SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

NOVEMBER 1901.

GENERAL PHYSICS.

2070. *Surface Tension of Liquid Air.* **L. Grunmach.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 914–918, July 25, 1901.)—The measurements were made by means of the method of capillary ripples. The density of the liquid was determined by a Mohr balance, and its composition ascertained by removing some in a small spoon and rapidly plunging it under a bell-jar filled with water. The gas so obtained was analysed by absorbing the oxygen by means of copper in an ammonia-ammonium carbonate solution. Temperature was measured with a petroleum ether thermometer of 59^{III} Jena glass (made by C. Richter, Berlin). Results :—

Oxygen Percentage.	Surface-tension (dym/cm).	Temperature.
49·9	11·61	− 190·3° C.
63·9	11·89	„
65·3	12·05	„
66·8	11·90	„
67·6	11·91	„
74·4	12·23	„
76·45	12·51	„
76·7	12·63	„

F. G. D.

2071. *Limnimeter.* **H. Ebert.** (Zeitschr. Instrumentenk. 21. pp. 193–201, July, 1901.)—This instrument records the amplitude and frequency of waves on lake surfaces. It consists of a cylindrical float or piston, working in a vertical cylinder which can be lowered into the water. The outer cylinder is intended for excluding from the records the fortuitous waves due to wind or to direct mechanical disturbances. The vertical movements of the piston are transmitted by means of a Hooke's joint to a stylus giving a trace on a recording drum. The apparatus is fully described, and examples of the sinuous records from Geneva are given, showing among other things the interference curves for various sets of pulsations. R. A.

2072. *Nineteenth Century Clouds over the Dynamical Theory of Heat and Light.* **Kelvin.** (Phil. Mag. 2. pp. 1–40, July, 1901. Lecture delivered at the Royal Institution of Great Britain, April 27, 1900.)—Cloud I. concerns the relative motion of ether and ponderable bodies. Fresnel's and Young's hypotheses being inconsistent with the elastic-solid theory of ether, the relinquishment of the doctrine that two portions of matter cannot jointly occupy the same space is suggested ; ponderable bodies may then be assumed not to displace ether as they move, while each atom alters the density-distribution of the ether within the space which it occupies itself. This hypothesis will explain (1) how matter can act on ether so as to produce light, (2) why the speed of light is less in transparent ponderable matter than in pure ether, (3) the aberration of light ; but it is inconsistent with Michelson and Morley's experimental conclusion that ether in the earth's atmosphere is motionless relatively to the earth, unless indeed the motion of ether through matter alters its linear dimensions. This cloud must be regarded as still very dense.

Cloud II. relates to the Boltzmann-Maxwell doctrine of the equal partition of the average kinetic energy of a system among all its degrees of freedom. After a short history of its formulation, the relation $k - 1 = 2/3i\,(1 + P)$ deduced from it is discussed for some simple cases, and the results are held to absolutely disprove the doctrine. To confirm this disproof elaborate calculations for several test cases have been carried out, some directly and others by the aid of a lottery, and it is found that (1) when a particle moves on a triangular billiard table with angles of 97°, 53½°, and 29½°, and undergoes, 599 reflexions, the ratios of the average components of kinetic energy in different directions to the actual kinetic energy are not uniformly 0·5, according to the doctrine, but vary between 0·5363 and 0·4637 ; (2) when the table has a circular boundary of infinitely small semicircular corrugations, the average radial and average transversal components of the kinetic energy for 142 reflexions are not equal, as the doctrine requires, but in the ratio 346 : 279 ; (3) when a rotator, formed of equal masses rigidly connected by a massless rod of negligible length, is reflected backwards and forwards between two parallel planes, the average rotatory and translatory kinetic energies for 109 reflexions are in the ratio 95 : 62, instead of being equal. Similar results are also obtained on considering the motion of a heavy particle which bounces on a horizontal floor with semicircular cylindrical hollows of infinitely small radius, and that of a heavy rotator as above bouncing on a plane floor, and the motions of the same bodies when not heavy but attracted to the floors by a force varying as the distance ; also in other cases.

It is incidentally suggested that the atoms of so-called monatomic gases may have satellites—query, J. J. Thomson's ions—of exceedingly small mass in comparison with their own ; this would account for the complexity of their spectra and also for the slight differences from $\frac{5}{3}$—invariably in defect—of the ratios of their specific heats. R. E. B.

2073. *Ether and Gravitational Matter in Space.* **Kelvin.** (Phil. Mag. 2. pp. 161–177, August, 1901.)—The author refers to his Baltimore Lectures, 1884, of which this paper is an amplification, and which he hopes shortly to republish. Then follows a note on the possible density of the ether, and on the mechanical value of a given volume of sunlight. This mechanical value can be calculated in heat units from Pouillet's researches. That being known, the mechanical energy in the given volume is known, and if we know the mass of the contained ether we can thence determine its velocity of vibration as the sunlight passes through it, or if we know the velocity we can determine the mass. The result obtained is that the mass in grammes of a cubic kilometre of ether near the sun is $20{\cdot}64 \times 10^{-7} \times n^2$, where n is the ratio of the maximum velocity of vibration to the velocity of light. This ratio cannot be calculated with certainty, but it seems improbable that it can be greater than $\frac{1}{50}$. The author adds in a note under date November, 1899, that we have strong reason for believing the density of ether to be constant throughout space, whence this constant density, that of water being unity, should be not less than 5×10^{-18}. These considerations lead us, he says, to the conclusion that ether and matter are not mutually exclusive, but may freely occupy the same space, or interpenetrate each other. He then calculates how much compressing force is exerted on the ether by the sun's attraction, and he arrives at the conclusion that the mean density of ponderable matter throughout any very large spherical volume in space is less the greater the radius.

(In these calculations it is assumed that the attraction between masses at all distances, however much greater than interplanetary distances, follows the Newtonian law.)

The author considers, for instance, a sphere where radius is $a = 3{\cdot}09 \times 10^{16}$ kilometres, that being the distance of a star whose parallax is 0·001 of a second, and proposes the question whether there can be as much matter as 10^9 times the sun's mass within such a sphere. If there were, the mean normal force of attraction over the surface of that sphere would be $1{\cdot}37 \times 10^{-11}$ times that of gravity at the earth's surface. It is possible thence to calculate the mean velocity which a body outside of the "*a*" sphere would acquire under the influence of that attraction in a given time. In one year it, for instance, would be $4{\cdot}32 \times 10^{-6}$ kilometres per second. The author concludes that given such a number of masses, initially at rest 25 millions of years ago, or so situated then that they are now distributed through the "*a*" sphere with approximate uniformity, they would now have, on an average, some such velocities of motion through space as we have reason to believe the visible stars do in fact possess.

Kelvin also calculates from the ratio of starlight to sunlight the density of stellar distribution, assuming every star to be equally luminous with the sun. He tests by this means the old hypothesis that if we could see far enough we should see a star in every possible direction, and the only reason why we do not is that light suffers absorption in passing through space. In order that this hypothesis might be true, the outlying stars must be so distant that the time of passage of light from them to the earth would be 3½ million times the life of a star, calculated in case of the sun to be about 50–100 millions of years. S. H. B.

2074. *Interpretation of Seismic Records.* **A. Cancani.** (Accad. Lincei, Atti, 9. pp. 94–96, 1900.)—The author contests Viola's assertion [see Abstract No. 1987 (1900)], that a vertical pendulum can show neither the direction nor the duration of a seismic disturbance, but only the moment at which it occurs, and that the subsequent movements are due to vertical oscillations. He adduces evidence showing that oscillations of the same period as those registered by the seismograph have been observed by other means, and that in certain cases, where the disturbance lasted several minutes, it was impossible to attribute the registrations merely to the initial shock. G. H. B.

2075. *Effect of Wind on Seismic Instruments.* **G. Agamennone.** (Accad. Lincei, Atti, 9. pp. 308–318, 1900.)—Delicate pendulums, or seismometers, show very frequently spontaneous oscillations which are attributed by many observers to causes other than seismic. To determine their cause, the author made observations on an instrument in the Rocca di Papa observatory; it was attached to a central pillar in the observatory, built on the rock, and entirely separated from the building, and would therefore appear to be well protected from any but seismic influences. Nevertheless the author concludes that its oscillations are attributable in many cases to the effect of wind, and gives details of the observations which led him to this conclusion. G. H. B.

2076. *Thunderstorms.* **A. F. Sims.** (Elect. Rev. N.Y. 39. pp. 132–133, Aug. 3, 1901. From a pamphlet published by the General Electric Company.)—*Remarks on Thunderstorms and their Forecasting in the United States.* The thunderstorms generally develope in the south-east quadrant of a low pressure area, 400 or 500 miles from its centre, and travel towards the east or south-east, at less speed than the low barometer area, the region favourable for their development spreading out in a fan-like manner. Thunderstorms occurring in the south-west quadrant of a low barometer area are generally sporadic in character; small storms only are affected by the topography of the country. H. B.

2077. *Scintillation of Stars.* **K. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 110, IIa. pp. 73–123, Jan.–March, 1901.)—The first twelve pages are occupied by a historical sketch of the various theories from the time of Aristotle, the last twenty by a discussion of recent literature on the subject, and the remainder by a discursive account of the author's views and experiments. Various forms of scintillometers are described. The phenomena are attributed to irregular refraction in the earth's atmosphere, due to successive warmer and cooler air currents, or to this cause combined with regular atmospheric dispersion. The effects were imitated in the laboratory by the aid of a piece of window-glass and a prism, the action of the wind being represented by moving the glass. The author's observations lead him to the result that the wave fronts from the fixed stars, originally plane, acquire, in passing through the atmosphere, irregular convexities and concavities continually changing with the motion of the air. The depth of such a convexity is of the same order of magnitude as a light wave, the breadth is of the order of a decimetre, and the minimum value of the radius of curvature may be about 4,000 m.

A. E.

REFERENCES.

2078. *Cellular Whirlpools in a Liquid Layer.* **H. Bénard.** (Journ. de Physique, 10. pp. 254–266, April, 1901.)—Descriptions of various optical devices for studying and recording these [see Abstracts Nos. 1815 (1900), and 86 (1901)]. Measurements obtained are given. A full paper on the subject, by the same author, will be found in the Annals de Chim. et de Physique, 23. pp. 62–144, May, 1901. In this paper the author suggests certain biological analogies. A. D.

2079. *Internal Friction of Gases.* **P. Breitenbach.** (Ann. d. Physik, 5. 1. pp. 166–169, May 4, 1901.)—A discussion of Sutherland's theory (Phil. Maga., 1893), which is apparently confirmed by experimental results. A. D.

2080. *Flow of Liquids in Thin Films.* **H. S. Hele-Shaw.** (Comptes Rendus, 132. pp. 1306–1312, June 3, 1901.)—A brief account of the author's stream-line method of studying the flow of viscous liquids in thin films, with its application to the solution of electrical and magnetic problems in two-dimensional space. A. H.

LIGHT.

2081. *Apparatus for Driving the Photographic Plate in using a Siderostat.* **G. Lippmann.** (Journ. de Physique, 10. pp. 415–417, July, 1901.)—As is well known, the siderostat brings only one point of the heavens to rest, the remainder of the field rotating around this point with varying velocity, and several methods have recently been proposed for imparting a similar rotation to the plate receiving the image. [See Abstract No. 1477 (1901).] The author shows that the device used for driving the mirror of the siderostat may also be employed for driving the plate, and remarks that the adjustments involved are comparatively simple. A. E.

2082. *Line Image by Cylindrical Mirror as Meridian Mark in Telescope.* **G. Lippmann.** (Journ. de Physique, 10. pp. 413–415, July, 1901.)—This paper describes an apparatus for use in measuring right ascension, and whose object is to render the meridian visible in the telescope field in the form of a bright line. It consists of two parts, both of which remain fixed during the observations: (1) A collimator, with hole or slit, mounted on pillars with its axis in the plane of the meridian. (2) A hemi-cylindrical mirror a few centimetres in diameter, with its axis horizontal and at right angles to the meridian, placed so as to receive the rays from the collimator. The reflected rays extend from 0° to 360° in planes parallel to the meridian. Owing to this fact the apparatus, though remaining fixed, remains applicable for all declinations. These rays, falling on the telescope objective, form an image at its focal plane consisting of a very fine bright line. This line marks the place of the meridian in the field. It is not necessary to carefully adjust the position of the telescope, which merely plays the part of an ocular. All parts whose adjustment is of importance remain at rest during the observations—an advantage as regards stability. The method is applicable to photography. A. E.

2083. *Influence of Mechanical Stress on Refractive Index.* **F. Pockels.** (Phys. Zeitschr. 2. pp. 693–695, Aug. 31, 1901.)—It has been shown that the refractive index of flint glass increases with the temperature. In order to get the temperature effect cleared from the influence of change in density, Pulfrich used the Gladstone-Dale, or the Lorentz, formula, connecting density with refractive index, although they have not been shown to hold for solids, and in fact give widely different results if the index is high. The author therefore investigates the influence of mechanically produced density changes on the refraction. Light is transmitted through a plate 5 mm. thick, the retardation along the axis of pressure being measured by a Jamin interferometer, and the relative retardations of the two perpendicularly polarised rays by a Babinet compensator; a known stress is then applied to the plate by means of a lever. It is then found that the component polarised perpendicular to the direction of the pressure is retarded relatively to that parallel to the pressure, and, contrary to the usual result, the glass becomes positively double refracting. Finally, the change in the refractive index with density, the pressure remaining constant, being found experimentally, it is seen that the Gladstone-Dale formula gives the nearest approximation, the Lorentz formula being altogether inapplicable. R. S. W.

2084. *Phase-change at Incidence near Critical Angle.* **J. M. de Lépinay.** (Comptes Rendus, 133. pp. 150–152, July 15, 1901.)—In utilising Herschel's fringes for measurement of refractive indices based on observations of the angle of total reflection, the author found that the positions of the first few fringes differed systematically from those assigned to them by theory. The observed facts can only be explained on the assumption that, for angles of incidence nearly equal to (but less than) the angle of total reflection, a retardation of phase is introduced by reflection at the first bounding surface of the thin layer, and also an advance of phase by reflection at the second surface. A. E.

2085. *Constitution of White Light.* **O. M. Corbino.** (Comptes Rendus, 133. pp. 412–414, Aug. 26, 1901.)—Two opposite views of the constitution of white light are stated, and a theoretical decision between them, based on known experimental results, is arrived at. Gouy maintains that the constituents of the spectrum of white light are the sinusoidal components of a single complex vibration, and are capable of mutual interference; while Carvallo regards the separate radiations as completely independent, and therefore incapable of interference with one another. The latter view is supported by the spectroscopic observation of beats produced by two pencils of white light, one of which is slightly altered in period by means described elsewhere by the author and by Righi. In the case of monochromatic light, alternations of light and darkness are observed; in the case of white light, movable fringes are seen. In the latter case the fringe system should exhibit no alteration when the change of period is effected, if the hypothesis of Gouy is true. The fringes are, however, seen to move, and hence it follows that interference takes place only between radiations which had the same period in the source before the alteration of period, and not between those which, originally different, have been brought into coincidence of period. Hence the second hypothesis is accepted. J. W. P.

2086. *Interference Fringes by Circular Double Refraction.* **Damien.** (Soc. Franç. Phys., Bull. 169. p. 4, 1901.)—An account of apparatus and experiments analogous to those described in Abstract No. 1873 (1901), but due to circular double refraction instead of rectilinear. In these second experiments the quartz vessels of Biot are replaced by quartz vessels whose plane face, instead of being parallel to the axis, is perpendicular to the axis of the quartz. The *fringes of subtraction*, analogous to the fringes of the prisms of Sénarmont, are produced by projecting the image of two such vessels formed of quartzes of contrary signs superposed with their centres distinct, and placed between two crossed Nicols. Similarly the *rings of addition* are obtained by using vessels formed of quartzes of the same sign; only, on account of the feebleness of circular double refraction, compared with rectilinear, the vessels must in this case be very deep. J. J. S.

2087. *Visibility and Singularities of Interference Fringes.* **Raveau.** (Soc. Franç. Phys., Bull. 165. p. 11, 1901).—If SA . . . A′S′ and SB . . . B′S′ are the two paths of a light ray between two points, S and S′ on opposite sides of an interference apparatus, then when S is the luminous point, the common normal S′F to A′S′ and B′S′ is a tangent to the intersection of the pair of corresponding wave surfaces, and gives the direction of the fringes observed around S on a screen containing this normal. If S′ is the source, then S′F is the direction of the slit required to give sharp fringes at S.

The author has considered the special case in which A′S′ and B′S′ coincide, so that S′F becomes indeterminate, and finds that with a luminous point at S the fringes at S′ will no longer be approximately rectilinear, but will be determined by equations of the form $ax^2 + bxy + cy^2 = k\lambda$, from which he deduces a geometrical theory of Jamin's interference apparatus, together with some characteristic properties of the fringes obtained with crystalline laminæ. Taking S′ as the luminous point leads to the theorem—If two rays, derived by the aid of an interference apparatus from a single source, intersect again, sharp fringes will be obtained at the intersection point without the use of a slit at the source. G. W. de T.

2088. *Velocity of Light in Magnetic Crystals.* **G. Scalfaro.** (Accad. Lincei, Atti, 10. pp. 109–118, Feb. 17, 1901.)—In the electromagnetic theory of light, to harmonise with Fresnel's laws, the constants of magnetic permeability must be equal in all directions. The propagation of light in magnetic crystals was studied by A. Sella, Rend. Acc. Lincei, 1895, II semestre, p. 287. The author finds that in magnetic crystals, both monoclinic and dimetric, the velocity of propagation of light follows Fresnel's laws within the limits of observational error (which affect only the fifth place of decimals in the values of the radius-vector of sections of the surface of normal velocity), and not the electromagnetic theory. A. D.

2089. *Law of Rationality of Indices in Crystals.* **C. Viola.** (Accad. Lincei, Atti, 9. pp. 301–308, 1900.)—The author considers that Haüy's law of rationality of indices has no value in crystallography, since it is not a law that can be proved experimentally, either from a consideration of the angular measurements or of the symmetry; for from the law of rationality it is possible to deduce a symmetry which is not possessed by the crystal, and symmetry actually found in a crystal does not follow from this law. The two fundamental notions on which crystallography should be based are (1) the physical homogeneity of the crystal, and (2) the fact that there are only 32 different kinds of symmetry possible, the axes of symmetry being binary, tertiary, quaternary, and sexary. T. H. P.

2090. *Indices of Refraction of Mixtures of Liquids.* **J. de Kowalski** and **J. de Modzelewski.** (Comptes Rendus, 133. pp. 33–35, July 1, 1901.)—The indices of refraction in mixtures of liquids do not present the anomalies which the dielectric constants do. It appears that anomalies only occur in the infra-red, through the absorption changing in that region in an irregular manner. A. D.

2091. *Dependence of Radiation-Absorption of a Gas on its Density.* **K. Ångström.** (Ann. d. Physik, 6. 1. pp. 163–173, Aug., 1901.)—The author describes experiments by which he shows that the amount of radiation absorbed by a gas, particularly carbonic acid, depends upon the density of the gas, in opposition to the view that it remains constant provided that pl is constant, p being the pressure and l the thickness of the gas layer penetrated. The absorption is shown to increase with the density, owing to a broadening of the absorption band. Two methods of experimenting were followed with consistent results; in one, two tubes were so connected together that, after the absorption of the gas contained in one had been measured, the gas could be allowed to expand into the other, which had been exhausted; thus the absorption of the same quantity of gas under the same conditions, except as regards pressure, could be determined. The author considers that thus the results of Arrhenius [see Abstract No. 1907 (1901)] are harmonised with his own, and that his previous conclusions as to the absorption of atmospheric carbonic acid gas are confirmed. W. E. T.

2092. *Photographic Plates Sensitive to Ultra-violet Light.* **V. Schumann.** (Ann. d. Physik, 5. 2. pp. 349–374, 1901.)—The sensitiveness of gelatine dry-plates diminishes rapidly for wave-lengths below 220 $\mu\mu$, on account of the opacity of gelatine for such waves. The author prepared plates sensitive to wave-lengths beyond 185 $\mu\mu$ in 1893 (Sitzungsber. d. k. Akad. d.Wisseusch. zu Wien, 102, p. 415), and the present paper describes an improved method of preparation, giving far better results. A gelatine emulsion very rich in silver bromide is prepared, and allowed to set; it is then cut into small pieces, washed, and dissolved in a large quantity of water, and, after filtration through slag wool, poured on to glass plates. The silver bromide settles, and, after half an hour, the emulsion is poured off, leaving a thin layer of silver bromide. The plates can be used as soon as dry, but gain largely if kept for one or two months; if kept for a longer time, they become fogged. If the emulsion, before filtering, is freed from the larger bromide particles by levigation, the plates are less liable to show spots. The film is extraordinarily sensitive to pressure, even brushing with a camel's-hair brush producing streaks on development. The author recommends a pyro-soda developer.

To white light the plates are far less sensitive than ordinary gelatine plates, and are more sensitive only beyond 230 $\mu\mu$. This is of great advantage in spectral photography, as the diffused light from the prisms and lenses has comparatively little effect. Beyond 182 $\mu\mu$ the gelatine plate gives no image at all, while the author's plates increase in sensitiveness as the wave-length diminishes. The paper contains very full details for preparing the plates.

G. H. B.

2093. *Blue-printing by Electric Light.* **H. G. Reist.** (West. Electn. 28. p. 423, June 22, 1901. Paper read before the American Society of Mechanical Engineers at Milwaukee, May, 1901.)—The paper describes the arrangements adopted by the General Electric Company for printing by electric light. Each light consists of two 5-ampere enclosed arcs, in opal globes, with reflectors; these are suspended from trolleys running on girders along the ceiling, and are brought over the printing frame. The time required to print is about three times as long as in sunlight in February. Owing, however, to greater ease in handling, the cost is less than that of printing by sunlight, the prices being, respectively, 2·09 and 2·039 cents per print.

G. H. B.

2094. *Stereoscopic Experiments and Measures.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 21. pp. 221–224, Aug., 1901.)—The author has devised a simple apparatus without lenses or prisms. It consists of a pair of metal tubes bound together, each 1 m. in length and 55 mm. in diameter. The eye end is closed, except for a long horizontal slit 2 mm. in width. The other end has a holder for the objects which take the place of stereoscopic pictures, viz., metal plates pierced with holes, or glass plates with figures pasted on them. Outside the carrier are two long vertical pointers, whose distance apart can be altered by micrometer screws. Let E_1, E_2 be the positions of the two eyes, O_1, O_2 two objects (one in each tube) which are seen as one, P the intersection of the lines E_1O_1, E_2O_2, then P is the virtual image, and we have $E_1P : E_1O_1 :: E_1E_2 : E_1E_2 - O_1O_2$; whence E_1P, the distance from the eye to the virtual image, is obtained. The distance between the eyes can be found by making the two pointers coincide with a very distant point. The formula shows that EP is > EO, or that the far end of the tube appears further off than it really is, with the curious result that an external object whose distance from E is < EP, appears to lie inside the tube. If the lines E_1O_1, E_2O_2 diverge, the image P falls behind the observer. The author remarks that all normal eyes are capable of diverging their axes, an action never called for by nature, though it may be—and generally is—required for uniting the stereoscopic pictures ordinarily sold. The maximum amount of divergence possible may be measured with the apparatus, by turning it upon a white surface, and screwing the pointers apart until the eyes are no longer able to see them as one. The image then suddenly appears double, and, by the help of the pointer readings at this point, the angle of divergence can be calculated. A. E.

2095. *Brightness of Vision in Men and Animals.* **A. Gleichen.** (Archiv Math. Phys. 1. pp. 238–245, July 23, 1901.)—The author first finds an expression for the brightness h of the retinal image of a small surface element normal to the axis. For the human subject, this expression reduces to $h = 0{\cdot}00496\, k\pi r^2$, r being the radius of the iris, and k a constant. For a fish, the iris being fixed, it becomes $h = 0{\cdot}213\, k\pi$. By putting $r = 2$ mm., the value corresponding to ordinary daylight, the result is arrived at that the fish sees 10·7 times as brightly as a human eye. When $r = 4$ mm. this ratio diminishes to 2·7. A. E.

2096. *New Form of Lantern Polariscope.* **F. E. Ives.** (Frank. Inst., Journ. 152. pp. 157–160, Aug., 1901.)—The instrument here described gives vertical projection, instead of horizontal, as in the usual type. This is obtained by using an inclined plane mirror, which receives the rays from the polarising bundle of glasses, and sends them vertically upwards to the objective, analyser and horizontal stage. Details and measurements are given. The transmitted light from the bundle of glasses can also be used for ordinary direct projection; by replacing the bundle by a silvered mirror ordinary vertical projection is obtained. J. W. P.

2097. *Rotatory Power of Sugar.* **H. Pellat.** (Annal. Chim. Phys. 23. pp. 289–316, July, 1901.)—This paper describes an investigation undertaken for the French Government Commission for the Unification of Methods of Analysis of Alcohols and Sugars. The sugar used in the experiments came direct from the factory, where it had been refined with special care. It gave a percentage of ash only 0·00063 of its mass. Apparatus was specially constructed for the investigation. (I.) The first step was to determine the "prise d'essai," or the mass of pure sugar which must be contained in 100 cc. of a solution at 20°, in order that a column 20 cm. in length may rotate the plane of polarisation of the D line through 21°.67. The result obtained was 16·284 gr., or, allowing for the presence of impurities, 16·275 gr. From the former number the value 66·536° is deduced for $(\alpha)^{D}_{20^\circ}$, the rotatory power, a result practically identical with Mascart and Bénard's, which was 66·538°. (II.) For β, the coefficient of apparent variation of rotatory power with temperature, very concordant results were obtained, the mean being $-0{\cdot}00036$ (for temps. between 14° and 30°). The expansion of the bronze containing-tube is here involved. If the coefficient of linear expansion for bronze be taken as

0·00002, and γ be the coefficient of true variation, we have $\beta = \gamma + 0{\cdot}00002$ and therefore $\gamma = -0{\cdot}00038$. For a tube of glass with coefficient 0·00001 we should have $\beta' = \gamma + 0{\cdot}00001 = -0{\cdot}00037$. Hence if R_t, the rotation for temp. t°, be observed, the rotation for 20° is given by $R_{20} = R_t\,[1 + 0{\cdot}00037\,(t-20)]$. (III.) As regards variation with wave-length, the following results were obtained, a being the ratio of rotation for λ, to the rotation for the mean of the D lines. The substance emitting the ray is indicated in each case.

λ	a	λ	a
Cd 0·64385 μ	0·8290	Cd 0·53790	1·2162
Ba 0·61418	0·9150	Cd 0·50859	1·3718
D 0·58930	1·0000	Mn 0·47660	1·5796
Cu 0·57002	1·0741	Cd 0·46782	1·645

The law $a \propto 1/\lambda^2$ does not suffice to represent these observations. The formula $a = A/\lambda^2 + B/\lambda^4$ was tried, and with $\log A = \bar{1}{\cdot}512529$, $\log B = \bar{3}{\cdot}879098$, gives good agreement, the greatest discrepancy being only 1/1000. A. E.

2098. *Universal Spectrometer.* **G. Melander.** (Zeitschr. Instrumentenk. 21. pp. 224–226, Aug., 1901.)—This instrument can be used for studying any portion of the spectrum, either visually, photographically, or photometrically, with two different dispersions. Relative wave-lengths, it is stated, can be determined with an accuracy of 0·015 $\mu\mu$. The spectrum is 30°, or 9 cm., in length (with two prisms), and two lines can be seen between the D lines. The four main parts of the apparatus are the polariscope, the collimator, the prism case and the camera tube. For visual work a micrometer eyepiece is attached to the end of the camera tube. The polariscope can be turned out of the way if desired ; when in use, the light from it is reflected by a prism into the upper half of the slit. The collimator lens is trebly corrected photographically. The camera lens is a Zeiss stigmatic Ser. VII. No. 5, of 36 mm. aperture, and 412 mm. focus. Two exactly similar prisms are provided, one or both of which can be used, the telescope being pushed further into the prism box in the former case. A. E.

2099. *Delicacy of Spectrum Analysis.* **W. Schuler.** (Ann. d. Physik, 5. 4. pp. 931–942, July, 1901.)—The author gives tables of the least quantities of different metallic salts required to produce the characteristic flame spectra. He finds that (1) in the two first periodic groups, the indications with the lower metals decrease in delicacy as the atomic weight increases ; (2) the delicacy, in haloid salts, diminishes as the atomic weight of the halogen increases, and in oxy-compounds as the number of atoms of oxygen is increased ; (3) the delicacy of metallic spectra is considerably lessened by mixing the coal gas with HCl or still more with vapour of chloroform. S. R.

2100. *Spectrum Analysis.* **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 110. IIa. pp. 181–203, Jan.–March, 1901.)—I. The author discusses the investigations of W. J. Humphreys and J. F. Mohler (Astroph. Journ. 1896, 1897) on the influence of the pressure on the wave-lengths of the arc lines, and considers the possibility of calculating the spark pressure from the displacement of the lines. The observations of F. Exner and E. Haschek on the spark spectra of the elements furnish material for the discussion. The following results are reached :—

1. In the spark spectrum considerable displacements of lines occur in

the sense of an increase of the wave-length; the analogue of those observed by Humphreys and Mohler in the arc under pressure, but they attain higher values.

2. It is supposed that the line displacements are only conditioned by a prevailing pressure in the sparks; the experimental value is determined, and the spark pressure is calculated, from the displacement in the spark, and that in the arc; then very varying values are arrived at with the same elements, always keeping to the chosen lines.

3. Lines of equal displacement in the arc appear very differently displaced and inverted in the spark. The rule that the lines of the series of Kayser and Runge show equal displacements does not hold good for the spark.

II. With regard to the dependence of the wave-lengths on the density of the incandescent vapour, the results indicate that with increasing density displacements occur, both in the case of the arc and the spark spectrum. These concern both the lines and their inversions—a phenomenon which is conditioned by the constitution of the incandescent vapour.

III. The connection of the wave-lengths with the mode of production of the incandescent vapour is next considered.

Displacements of lines in the arc and spark spectra are common, and, under certain circumstances, reach considerable magnitudes. The observed value of the wave-lengths depends in a high degree on the momentary conditions of the experiment, and these cannot always be controlled.

The question arises as to how far the wave-length data, which hold good for the transformer spectrum, are transferable to the Ruhmkorff coil spectrum. This question cannot in general be answered. The wave-lengths of the lines are to a great extent dependent upon the energy consumed. The consumption of energy is, however, greater with the transformer: somes lines, consequently, are strongly displaced towards the red. J. J. S.

2101. *Spectrum of Hydrogen from Metallic Arc.* **O. H. Basquin.** (Astrophys. Journ. 14. pp. 1-16, July, 1901.)—The author first outlines the previous work on the arc spectra of gaseous elements by Liveing and Dewar. Then follows an account of his own experiments, using a rotating metallic arc in a gas-tight chamber which could be filled with any desired medium. Examination of the spectra was made both visually and photographically with grating spectroscopes. The elements examined were aluminium, copper, magnesium, coin-silver, sodium, tin, and zinc. With the exception of sodium, all the arc spectra show Hα and Hβ, and many also show Hγ. Hα is usually sharp, the others broad, hazy, and ill-defined. Hδ is well shown in the spectra of tin, silver, and copper.

In addition to pure hydrogen, the lines have been observed when the arc was taken in ammonia and coal gas, and also in air, with a small jet of water playing on the poles.

Some attention is next devoted to the question of chemical action in the arc. Certain sets of lines and flutings are found which are not present in the ordinary arc taken in air, and, supposing these to be due to compounds, detailed descriptions and measures are given. A general conclusion is cited that the intensities of the hydrogen lines coming out in the arc spectra of various metals are (roughly) inversely proportional to the intensities of the characteristic flutings of these metals. Also the general effects of the hydrogen atmosphere may be summarised as follows:—(1) The arc works poorly in hydrogen. (2) The intensity of the whole spectrum is greatly reduced in hydrogen. (3) Those metallic lines which belong to the series of Kayser and Runge are uniformly reduced in intensity. (4) Other lines are reduced in intensity but not uniformly. (5) Certain lines supposed to belong to the spark spectrum make their appearance in the arc in hydrogen.

An excellent reproduction of the photographed spectra of tin in hydrogen and aluminium in ammonia accompanies the paper. C. P. B.

2102. *Continuous Spectra of Liquids and Solids.* **L. Décombe.** (Comptes Rendus, 133. pp. 282–284, July 29, 1901.)—The author proposes to account for the continuous spectrum exhibited by an incandescent solid or liquid by assuming a special controlling action of neighbouring molecules upon each other at the superficial boundaries of the body. In the interior, the homogeneity of the molecules will cause mutual neutralisation of the disturbing forces, but at or near the free surfaces this will not be so; assuming then that each individual particle continues to radiate, the integration of the actions of all will give light of all wave-lengths. Numerical examples are given in illustration of this view. C. P. B.

2103. *Ultra-violet Spectrum of the Alternating Current Discharge.* **A. W. Wright** and **E. S. Downs.** (Amer. Journ. Sci. 12. pp. 66–73, July, 1901.)—When an induction coil is driven by an alternating current, the spectrum of the arc between the terminals of the secondary is found to give a large number of lines; it is the purpose of the paper to discover their origin, but the author's efforts are at present confined to those in the ultra-violet. Photographs under various conditions are obtained by means of a Rowland grating, the sun's spectrum being thrown on the same plate, for comparison. The lines studied come where the red of the first spectrum and the ultra-violet of the second overlap. Staining the plates with various preparations showed that they were really in the ultra-violet, extending from a wave-length of 3063 down to 3134, and this was further proved by obtaining them in the first spectrum. The lines are not due to the electrode, and the authors think they are not due to water vapour alone, but rather to the various constituent gases of the air and combinations of them which are facilitated by the presence of water vapour, consisting, probably, for the most part, of nitrogen and its oxides. R. S. W.

2104. *Spectral Lines.* **C. Runge** and **F. Paschen.** (Ann. d. Physik, 5. 3. pp. 725–728, June, 1901; also Astrophys. Journ. July, 1901.)—J. R. Rydberg suggested in 1893 that various sets of triplets observed in the spectra of calcium, strontium, zinc, cadmium, and mercury were not made up merely of three single lines, but that those lines were accompanied by feebler ones. The distances of these weaker satellites follow certain laws observed by Rydberg. The lines of mercury, according to the observations of Kayser and Runge, he finds are not arranged in the same way as those of the other elements, and concludes that Kayser and Runge's observations are probably incomplete and that further observations are necessary to elucidate the complex triplets of the mercury spectrum. The authors have undertaken an investigation of the vibrations of mercury light in the magnetic field, and while their experiments are not yet complete they give some of their results in the present paper. These show that in fact the lines of the triplets observed and measured by Kayser and Runge must be supplemented by other weaker lines which accompany them. The observations of wave-lengths already made must be extended by more accurate determinations, as it is probable that the lines referred to as single all consist of several components.

Tables of the wave-lengths of the components of the two compound triplets observed, and also of the vibration numbers, are given in the paper. With the supplementary lines found by the authors the compound triplets in the mercury spectrum are closely analogous to the compound triplets in the spectra of calcium, strontium, zinc, and cadmium, but in the spectrum of mercury there appears to be one satellite more to each main line. J. J. S.

2105. *Displacement of Cadmium Line λ4800 by Pressure.* **W. B. Huff.** (Astrophys. Journ. 14. pp. 40–48, July, 1901.)—The author has been employed in investigating the influence of quantity, and of secondary substances, on the displacements of spectral lines of a substance produced by pressure. He concludes that the shift does not depend on the amount of metal present, and that the effect of a strange metal is considerable. For considerable pressures the relation between pressure and displacement appears to cease being linear. C. P. B.

2106. *Standard Wave-lengths of Solar Spectrum.* **Perot** and **C. Fabry.** (Comptes Rendus, 133, pp. 153–154, July 15, 1901.)—A series of standard lines, from λ4643·645 to λ6471·885, have been measured by the interferometer, and the reduced values are compared with the values given by Rowland; the residuals are shown in a curve which shows the departure of Rowland's scale from that of a perfectly normal spectrum. C. P. B.

2107. *Energy of Röntgen Rays.* **F. Leininger.** (Phys. Zeitschr. 2. pp. 692–693, Aug. 31, 1901.)—In trying to repeat the measurements of previous experimenters on the energy of Röntgen rays, the author found that, with the same arrangement of the bridge in which the bolometer is placed, he could observe no heating effect at all when the radiation fell on the strip. A comparison of the sensibility of his instruments with those of Rutherford leads him to the conclusion that a large galvanometer deflection should have been obtained. This negative result is shown whether hard or soft rays are dealt with. The author cannot reconcile his result with the fairly concordant results of other physicists. R. S. W.

2108. *Influence of Annealing on Transparency to Röntgen Rays.* **R. Malagoli.** (N. Cimento, 1. pp. 445–452, June, 1901; Memorie della R. Acc. di Sc. Lett. ed Arti in Modena, Serie 3, vol. 3.)—Faraday found that a film of gold or silver, if annealed, became more transparent to white light and lost its metallic lustre, but regained its original character if pressed between two agate surfaces. The author finds that if any difference is caused by annealing it is in the direction of making such films less transparent to Röntgen rays. The cause of both these effects appears to be that the metal arranges itself in thickened patches separated by a network of thinned-out metal, which follows the lines of rugosities in the gold-beater's skin used in making the leaf, and as a whole tends to shrink. Where the metal is held in position, or is of an appreciable thickness, the opacity to Röntgen rays is increased. A. D.

2109. *Effect of Temperature on Radio-active Substances.* **E. Rutherford.** (Phys. Zeitschr. 2. pp. 429–431, April 20, 1901.)—The radio-active compound is heated in a platinum tube, through which a 2 c.cm/sec. current of filtered air passes. The ionised air is received in a metal cylinder connected to one pole of a 800-volt battery, and a wire connected to an electrometer projects into the cylinder. Thorium and radium compounds were examined. These had their activities increased by heating up to a certain point: they then decreased and almost vanished and did not return on cooling. The heat effect on the emanation from radium is enormously greater than that on thorium, but, bulk for bulk, thorium is more powerful than radium at ordinary temperatures. Also the emanation from radium remains much longer active than does that from thorium, the reverse happening in the case where the activity is induced. At ordinary temps. the induced activity is always displayed by the kathode; on heating, it appears on both electrodes. Emanation is probably due to a chemical process in the material. G. E. A.

2110. *Radio-activity.* **E. Rutherford.** (Nature, 64. pp. 157–158, June 13, 1901.)—After referring to the papers by P. Curie and A. Debierne on the production of a radio-active gas obtained from radium [Abstract No. 1649, 1901], and to a paper of his own on the increase of the emanation by rise of temperature, Rutherford describes in the present article new experiments which point to the conclusion that the effects observed are due to a radioactive gas with a molecular weight probably lying between 40 and 100. The method employed was to examine the nature of the emanations from radium by measuring their rate of diffusion by an electrical method resembling that used by Loschmidt in 1870. The coefficient of diffusion of the emanation into air appears to have a value between 0·10 and 0·15, but probably nearer the former. From this value the limits of the molecular weight given above are deduced. J. J. S.

2111. *Velocity of Becquerel Rays.* **W. Kaufmann.** (Phys. Zeitschr. 2. pp. 602–603, July 13, 1901.)—A preliminary description of an investigation on the velocity of these rays and on the ratio of the electric charge of the carriers to their mass. The method is a photographic one in which the deflections due to a magnetic and an electric field are measured, and is especially designed to overcome difficulties arising from the facts that the deflected bundle gives a spectrum, and also renders the surrounding gas a conductor. R. S. W.

2112. *Uranium Radiation at very Low Temperatures.* **H. Becquerel.** (Comptes Rendus, 133. pp. 199–202, July 22, 1901.)—Observations on the uranium radiation at very low temperatures are of theoretical importance. A vertical hollow copper cylinder, closed at its lower end by thin aluminium, is placed at a short distance above a sheet of uranium, and the rate of charging of an insulated rod down the centre of the cylinder is observed. The cylinder being kept at a constant temperature, liquid air is poured over the uranium, when a large decrease in the rate of charging is found. This is due to the higher absorption of the less penetrating rays by the cold layer of air between uranium and aluminium. The final result appears to show that no alteration in the amount of radiation emitted can be found.

Dewar has shown that when a crystal of nitrate of uranium is plunged in liquid air it becomes luminous spontaneously, and attributes this to an electrical action provoked by a molecular contraction. The author has repeated the experiment, and comes to the conclusion that Dewar's explanation is the correct one. R. S. W.

2113. *Influence of Temperature on Light from Phosphorescent Bodies.* **F. J. Micheli.** (Archives des Sciences, 12. pp. 5–34, July, 1901.)—The author describes a number of experiments on the phosphorescence of various substances, and deduces the following conclusions: The initial intensity, the rate of diminution, and the refrangibility of the light emitted by the sulphides of the alkaline earths all vary with the temperature. The initial intensity of the light reaches a maximum at a temperature which is different for different sulphides. These sulphides have the power of storing up at a certain temperature more luminous energy than they emit at that temperature; the whole of the energy thus stored up is given up when the temperature is raised. With blue calcium sulphide the maximum of energy is emitted at a temperature between 40° and 60°, while for the energy stored up the maximum is at —10° to —20°; this latter temperature seems to coincide with the point of maximum value of the refrangibility of the emitted radiations. Those organic compounds which are luminous at the temperature of liquid air resemble the sulphides of the alkaline earths in that they are only susceptible of emitting light between certain limits of temperature and that the initial intensity and rate at which the luminosity diminishes vary with the temperature. While some kinds of glass are non-luminous, others emit a green light when phosphorescent; the influence of temperature on the phosphorescence of glass is only felt within limits far more remote than those given above for alkaline-earth sulphides and organic compounds. T. H. P.

REFERENCES.

2114. *Passage of Light through Prisms.* **Izarn.** (Journ. de Physique, 10. pp. 494–495, Aug., 1901.)—The paper contains an analytical demonstration of the construction for the passage of light at minimum deviation through a prism. C. P. B.

2115. *Experiments with Interference Fringes.* **G. Sagnac.** (Soc. Franç. Phys., Bull. 168. pp. 3–4; Discussion, p. 4, 1901.)—The first part of the paper deals with the secondary fringes produced in a Fresnel biprism by the light reflected from the plane face. By silvering this the existence of these fringes was made very noticeable. Then a quick method of adjusting a Jamin refractometer in white light is described, and also the method of producing Jamin fringes. C. P. B.

2116. *Theory of Dispersion.* **Carvallo.** (Soc. Franç. Phys., Bull. 168. p. 2, 1901.)—A slightly modified dispersion formula is given—

$$\lambda \sin h \frac{n}{\lambda} = K,$$

and examples quoted illustrating its application in comparison with other formulæ. C. P. B.

2117. *New Radio-active Substances.* **P. Curie** and **Mme. Curie.** (Intern. Phys. Congress at Paris, Report, 3. pp. 79–114, 1900.)—A method of measuring radio-activity by means of an electrometer is described, and a list of uranium compounds and their activities is added. The report deals also with thorium, polonium, and radium, the spectrum and atomic weight of the latter, and the penetrating power and activity-inducing power of the rays. G. E. A.

2118. *Radio-active Substances and their Radiations.* **G. B. Pegram.** (Science, 14. pp. 53–59, July 12, 1901.)—A *résumé.*

HEAT.

2119. *Boiling-point Thermometers.* **O. Hecker.** (Zeitschr. Instrumentenk. 21. pp. 133-138, 1901.)—Boiling-point thermometers made of the new Jena glass were tested for constancy. It was found that the three thermometers whose behaviour was investigated, which were constructed with a boro-silicate glass of Jena, exhibited great constancy. Such boiling-point thermometers serve to determine the gravity correction of the barometer, and hence with sufficient accuracy for meteorological purposes the intensity of gravity itself. They also serve as control instruments for aneroid and mercury barometers. A table is given exhibiting the daily results of the gravity correction for each thermometer for a period of five weeks. J. J. S.

2120. *Air-Thermometer.* **A. W. Kapp.** (Ann. d. Physik, 5. 4. pp. 905-918, July, 1901.)—To make the instrument more convenient for a single observer and at the same time to ensure accuracy to the tenth of a degree in observations up to 300°, alterations are made in the construction of the Jolly air-thermometer. In particular, the air vessel and the manometer are connected by a long capillary metal tube, and a valve of special construction is placed where this enters the manometer tube; the harmful space is thus reduced to very small dimensions, and the mercury is prevented from entering the capillary tube. Calculations show that, if the temperature of the room does not vary by 3°, the harmful space may be taken at the temperature of the room, and yet the temperature determined by the simple formula $T=(H-H_0)/(\alpha H_0-3\beta H)$, H_0 and H being the pressures corresponding to zero and the observed temperature, α and 3β the coefficients of increase of pressure of air and of expansion of the glass of the air vessel; a correction must be applied, which, however, may be taken from a calculated table.

W. E. T.

2121. *Improved Laspeyres Thermostat.* **A. Weinhold.** (Ann. d. Physik, 5. 4. pp. 943-944, July, 1901.)—The thermostat consists of two concentric glass cylinders. The outer closed annular space, from which a tubular glass condenser rises, contains sulphuric acid; the inner space is the receptacle. To ensure smooth boiling of the acid a weak current, just sufficient to cause slight electrolysis, is passed through the liquid. H. B.

2122. *Optical Pyrometer.* **L. Holborn** and **F. Kurlbaum.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 30. pp. 712-719, June 13, 1901.)—The limiting temperature which can be measured by the thermo-couple or the air thermometer is about 1,500° C., and beyond 1,200° it is very difficult to make measurements of any accuracy. The only method available for higher temperatures is photometry of the radiation of one particular wave-length. As Wien's law has been shown to hold approximately for the radiation of a black body, and as Lummer and Pringsheim have shown that a want of blackness in the radiating body has but small effect on its visible radiation, the method should give accurate results.

The authors describe a photometric device enabling two radiations to be compared with great accuracy. The radiating source is viewed through a tube provided with internal diaphragms, a plate of ruby glass being interposed between the eye and the tube. In the opening of the central diaphragm is fixed a stirrup of platinum-iridium wire, connected with a source of current, an ammeter, and an adjustable resistance. The tube is provided at each end with spectacle lenses, arranged to give images of the radiating source and the stirrup. The stirrup appears black against a bright field, but as its temperature is raised by increasing the current a point is reached when it disappears from the field of vision, corresponding to the point of equal red radiation from the radiating source and the stirrup. This point can be determined with great accuracy. The ammeter can be calibrated in degrees of temperature by comparison with a source of "black" radiation containing a thermo-couple. The platinum-iridium wire cannot be employed for temperatures above 1,200°, but the authors substituted for it a small 4-volt incandescent lamp, with equally good results. Tables are given showing that, within the limits of experimental error, the current is a linear function of the temperature in the case of the platinum-iridium wire, and a quadratic function in the case of the glow-lamp. These relations hold between the limits of 500° and 1,500° C., the latter being the highest temperature susceptible of measurement by the thermo-couple. Extrapolating the formula, the glow-lamp can be employed for temperatures up to 2,000°, and, by weakening the radiation from the source to be measured, the ammeter can be given a second scale for higher temperatures, determined from the intensity of red radiation by the aid of Wien's law. G. H. B.

2123. *Effect of Temperature on the Thermal Conductivity of Glass.* **J. Krüger.** (Ann. d. Physik, 5. 4. pp. 919–923, July, 1901.)—The results of previous workers being very inconsistent, the author has effected a new determination of the temperature coefficient of heat conductivity. He uses the method of Christiansen for these bad conductors. Paalhorn, by his method, has obtained results inconsistent among themselves, but this is shown to be due to a defect in his apparatus. For three kinds of glass of very different composition, the final result showed that for a rise in temperature of 1°, the heat conductivity decreased by about ·031–·045 per cent. R. S. W.

2124. *Relation Between the Specific Heat of a Liquid and that of its Vapour.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 110. IIa. pp. 176–180, Jan.–March, 1901.)—Assuming the potential energy of a liquid to be equal to its kinetic energy and the latter to be independent of the state of aggregation, the author concludes that the specific heat of a liquid is twice the true specific heat of its vapour, an approximate result obtained also by another method of reasoning. Comparison is made of the known specific heats for 10 substances, and numbers lying between 1·53 and 2·29 are found for the ratio. Water is, however, quite anomalous, having the ratio 2·84. R. E. B.

2125. *Specific Heat of Non-Electrolytic Solutions, II.* **W. F. Magie.** (Phys. Rev. 13. pp. 91–101, Aug., 1901.)—This is in continuation of a former paper [see Abstract No. 76 (1900)], with slightly improved apparatus and method. Solutions in water of cane sugar, dextrose, maltose, milk sugar, levulose, mannite, dulcite, resorcin, hydroquinone, pyrocatechin, and phenol were examined, and also solutions in alcohol of the last four substances. The molecular heats were found to be independent of the concentration both in aqueous and alcoholic solutions, if dilute, so that the osmotic pressure conforms to Gay Lussac's law, though Loomis has shown that it does not accurately obey

Boyle's law. Further, the molecular heats of isomers in solution may be the same in one solvent, but may differ in another, and consequently the molecular heat of a solute may differ with the solvent; hence the process of solution is not a mere passage of the molecules of the solute into a state in every way equivalent to the gaseous state, but the solvent must interact with the solute so as to change the structure and number of degrees of freedom of either or both of them.

The heat-capacity of an electrolytic solution is of the form $H + A - Bp$, where H is the heat-capacity of the pure solvent, p the dissociation-factor, and A, B constants. R. E. B.

2126. *Practical Attainment of the Thermodynamic Scale of Temperature.* **J. Rose-Innes.** (Phil. Mag. 2. pp. 130–144, July, 1901.)—The Joule-Thomson effect and $(\partial.pv/\partial p)_t$ for a gas are assumed to be functions of t, whence a characteristic of the form

$$p(v - \mathfrak{C}) = Rt.$$

The former function is taken to be of the form $\Sigma a_n/t^n$ and the constants are chosen so that for a particular value of t the latter function (which is $\mathfrak{C}$) is $-\Sigma a_n/(n+1)t^n$; for this three constants are found to be in general sufficient. Estimates are then made of the absolute temperature corresponding to the freezing-point both with constant-volume and constant-pressure gas-thermometers and with both hydrogen and nitrogen as the gas, and it is concluded that Chappuis's determinations of $(\partial p/\partial t)_v$ are not sufficiently exact. The corrections also to reduce the readings of both kinds of thermometer to the absolute scale are deduced. R. E. B.

REFERENCES.

2127. *Gas Engines Studied by the tφ-Diagram.* **B. Brunhes.** (Journ. de Physique, 10. pp. 309–325, May, 1901.)—The *generic*, as opposed to the *experimental*, theory of gas- and vapour-engines is more conveniently studied by use of the $t\phi$-diagram than of the pv-diagram, as the conditions regulating the efficiency may be obtained qualitatively by inspection and without calculation. The types considered are the Otto, the Charon with both the Ganz and the Letombe systems of regulation, and the Brayton (with isopiestic combustion and not explosion). R. E. B.

2128. *Second Law of Thermodynamics.* **O. Wiedeburg.** (Ann. d. Physik, 5. 3. pp. 514–547, June, 1901.)—*Assuming*—for the proof offered is inadequate—that Clausius' principle is expressed by $\int dQ/\vartheta < 0$, where ϑ is the temperature of the source or sink of heat as distinguished from that of the working substance, but asserting as a result of his reasoning the dependence of a change of entropy on the *mode* of a change of condition, the author discusses the formulation of, and the range covered by, the second law of thermodynamics. R. E. B.

2129. *Corrections for Thermal Losses in Calorimetry.* **J. W. Richards.** (Frank. Inst., Journ. 152. pp. 81–89, Aug., 1901.)

2130. *Electric Thermostat.* **S. W. Young.** (Electricity, N.Y., 21. p. 36, July 24, 1901. From the Journ. Amer. Chem. Soc.)—The author describes a simple thermostat, electrically controlled and heated electrically by means of incandescent lamps. The arrangement was found to be very satisfactory for temperatures such as 25° C. W. R. C.

SOUND.

2131. *Musical Intervals in Melody.* **G. Zambiasi.** (N. Cimento, 2. pp. 50–55, July, 1901.)—Cornu and Mercadier affirmed (Comptes Rendus, 1869–72) that while in harmony the actual scale of stringed instruments was $1 : \frac{9}{8} : \frac{5}{4} : \frac{4}{3} : \frac{3}{2} : \frac{5}{3} : \frac{15}{8} : 2$, in melody unaccompanied it was a comma $(\frac{81}{80})$ sharper in the third, sixth, and seventh of the scale. The author has investigated this with artistes' voices and a phonautograph, and finds the acoustic scale, not sharpened by a comma, very closely adhered to, with occasional exceptions in the sixth of the scale; but even then only in cases in which it seems to be felt that the fifth has, for the time, become a keynote. This is in accord with the difference between the ratio Ray/Doh = 9/8 and the ratio La/Sol = 10/9 : the latter ratio is too small by 81/80 to meet the requirements in such a case. The acoustic scale is therefore the true scale for melody, as well as harmony; and the Pythagorean intervals have a function limited to modulations. A. D.

2132. *Mechanical Effects of Stationary Sound Waves.* **B. Davis.** (Phys. Rev. 13. pp. 31–47, July 1901.)—This is a continuation of the experiments described in Abstract No. 88, 1901. If a small cylinder closed at one end be placed in a stationary sound wave (produced in a closed organ-pipe) it will set itself with axis perpendicular to the direction of the wave motion, and will experience a force driving the closed end towards the wall of the organ-pipe. In addition to the rotating mill previously described, there is here used a torsion balance consisting of two gelatine capsules suspended, at the end of a cardboard arm, from a fine platinum-silver wire. This, like the mill, can be moved to any part of the wave, and the force on the cylinders is thus measured. It is found that the curve obtained by plotting the rates of rotation of the mill against the distances along the wave from the node, approximates very closely to a sine curve. So also for the torsion balance, the curve of square root of torsion and distance is a sine curve, showing that the force is proportional to the square of the amplitude of vibration at any point. The effect of varying (*a*) the cross-section of the cylinders, (*b*) the pressure of the blowing, (*c*) the position of the axes of the cylinders relative to the direction of the vibrating air particles, is investigated. A rectangular parallelopiped in place of a cylinder is found, *celeris paribus*, to give a much smaller force. The effect of density of the medium is examined by admitting various gases into the pipe. The force on the cylinder is found to be proportional, at moderate pressures, to the density of the gas. Figures and curves are given showing the relation observed between pressure of blowing and square root of torsion for air, illuminating gas, hydrogen, and carbon dioxide.

The mathematical discussion starts from Bernouilli's hydrokinetic equation—

$$\int dp/\rho = V - q^2/2,$$

in the usual notation. The integration of this by the relation $p = C\rho^\gamma$ gives, after certain approximations, $u_1^2 - u_2^2 = 2(p_2 - p_1)/\rho$ where u_1, u_2 are the velocities of the air particles just outside and just inside the closed end of the cylinder, and p_1, p_2 are the corresponding pressures. The cylinder is supposed to be lying with its axis transverse to the stream lines. Taking $u_2 = 0$, an excess pressure is arrived at which accounts for the phenomenon. If the force be measured by the torsion balance (the maximum pressure measured was 68·6 dynes per sq. cm.), the analysis leads to a value for the amplitude of the vibrating particles. Finally, similar phenomena observed by Clement, Guthrie and Kelvin, Dvořák and Boys, are cited. J. W. P.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

2133. *Potential of a Symmetrical System.* **T. J. I'A. Bromwich.** (Phil. Mag. 2. pp. 237–240, Aug., 1901.)—In Thomson and Tait's Natural Philosophy, 1890, art. 546, expressions are given for the potential at any point in space due to a uniform circular disc of radius a and density ρ. If the point, referred to the centre of the disc as origin, and its normal as axis, be r, θ; then for $r > a$—

$$V_0 = 2\pi\rho\left(c_1\frac{a^2}{r} + c_2\frac{a^4}{r^3}P_2 + c_3\frac{a^6}{r^5}P_4 + \&c.\right);$$

for $r < a$, and $\theta > \frac{\pi}{2} < \pi$—

$$V_1 = 2\pi\rho.\left(a + rP_1 + c_1\frac{r^2}{a}P_2 + c_3\frac{r^4}{a^3}P_4 +\right)$$

for $\theta > 0 < \frac{\pi}{2}$—

$$V_1 = 2\pi\rho\left(a - rP_1 + c_1\frac{r^2}{a}P_2 + c_3\frac{r^4}{a^3}P_4 +\right);$$

where P_n is Legendre's coefficient of order n, and c_n is the coefficient of x^n in $(1+x)^{\frac{1}{2}}$. By the continuity of potential, V_0 should be equal to V, when $r=a$, but apparently, from the above formula, this is not the case. The writer shows, by the properties of Legendre's coefficients, that the two expressions are in fact equal when $r=a$.

Again, when $r=a$, $\frac{dV_1}{dr} - \frac{dV_0}{dr}$ should be zero because there is no surface density on the sphere $r=a$. This also is shown to be correct. S. H. B.

2134. *Maxwell's Law, $K=n^2$, and the Molecular Structure of Bodies.* **A. Batschinski.** (Zeitschr. Phys. Chem. 38. pp. 119–121, Aug. 6, 1901.)—Maxwell's formula is—

$$u = (K-1)/(K+2)\text{..........................}(A)$$

where K is the dielectric constant. If, as Maxwell would suppose, $K=n^2$, where n is the index of refraction, this gives—

$$u = (n^2-1)/(n^2+2)\text{..........................}(B)$$

It would follow that if $K > n^2$, the formula (B) is incorrect, because (A) is deduced by Maxwell unconditionally. The researches of Landolt, Brühl, and others show, however, that (B) is probably correct for all liquids and gases. The writer explains the discrepancy by the consideration that Maxwell's relation ($K=n^2$) holds only in the special case where the supposed conducting particles in the dielectric are spherical, and are not in contact with others. The subject is also treated with reference to molecular association. Those liquids whose molecules are without doubt associated are found, as a rule, to obey the law $K=n^2$. But this, the writer says, cannot be taken as an unfailing criterion of association. S. H. B.

2135. *Absolute Potential in Insulated Network containing Capacity.* **C. E. Guye.** (Comptes Rendus, 133. pp. 388–390, Aug. 19, 1901.)—Knowledge of the absolute potential in such a network enables the requisite insulation to be determined.

Consider n insulated conductors, near an indefinite plane at zero potential or completely surrounded by a conductor at zero potential, and the u conductors connected to sources of electricity without capacity.

Whatever be the law of variation of p.d. between the n conductors, the instantaneous algebraic sum of the charges will be zero. Then it is possible to determine the absolute p.d. of each conductor, given the coefficients of capacity and electrostatic induction, and the p.d.'s between the conductors. Suppose the p.d. variations slow enough for electrostatic equilibrium at each instant, the p.d.'s in terms of the time may be expressed by equations of the type $V_n - V_1 = \phi_n(t)$, and the general equations of electrostatic equilibrium are of the type $M_n = \sum_0^n{}_k \gamma_{nk} v_k$, all the terms in v_0 being by hypothesis zero. Hence, if $\Gamma_n = \sum^n{}_k \gamma_{kn}$, then $\sum_0^n{}_k \Gamma_k v_k = 0$; therefore $v_1 = \sum_2^n{}_k \Gamma_k \phi_k(t) / \sum_1^n{}_k \Gamma_k$.

Particular cases: 1. When each conductor is enclosed in one at zero potential, the coefficients m vanish, and therefore $\Gamma_n = \gamma_{nn}$.

2. If the conductors form a symmetrical cable, all the Γ become equal, and therefore $v_1 = \sum^n{}_k \phi_k(t)/n$.

3. If the nth conductor surrounds the rest, all the Γ vanish and it easily follows that the potential of the enveloping conductor is then always zero.

W. G. R.

2136. *Electromagnetic Effects of Moving Charged Spheres.* **E. P. Adams.** (Amer. Journ. Sci. 12. pp. 155–167, Aug., 1901.)—This paper describes an experimental confirmation of Rowland's results. The moving conductor which carried the charge was made up of a number of copper spheres, soldered to the ends of an equal number of brass rods, screwed into a central brass hub, like the spokes of a wheel. Two such sets of spheres were mounted on the same insulating axle, and revolved at a high speed, one set being kept positively and the other negatively charged, by brushes connected to the terminals of a storage battery giving about 18,000 volts. The magnetic system consisted of an astatic pair, the lower needle being close to the moving conductors, and the whole enclosed in a brass tube closed at its lower end by a glass plate on which were strips of tin-foil.

Results were obtained which confirm Rowland's conclusions. J. E.-M.

2137. *Form Assumed by the Free Surface of a Liquid in Presence of an Electrified Body.* **A. Sella.** (Accad. Lincei, Atti, 9. pp. 80–86, 1900.)—The liquid is assumed to be a conductor. It will then, in presence of the electrified body placed over it, acquire an induced surface charge of density σ, the effect of which is a force $2\pi\sigma^2$ acting against the force of gravity, so that the parts of the liquid near the electrified body are raised above the surrounding level, forming a convex surface. The writer assumes the electrified body to be spherical, and first tests it as a charged point, then as a sphere of finite radius. In the case of the charged point, he finds that the convex portion of the liquid is bounded by a circle of radius $h/\sqrt{7}$, where h is the distance of the point from the liquid surface of the supposed plane. Also if ρ be the radius of curvature of the convex surface, ζ_0 its highest ordinate, $\rho\zeta_0 = h^2/\sigma$.

The case of a sphere of finite radius is treated with reference to Mathieu's "Theory of the potential and its applications to electrostatics and magnetism," and with use of Mathieu's notation. The values of ρ are calculated in case of mercury for given values of h. S. H. B.

2138. *Magnetic Effect of Electric Convection.* **H. A. Wilson.** (Phil. Mag. 2. pp. 144–150, July, 1901.)—When an electrostatic charge is set in rotation, we should expect to find a magnetic effect, but Crémieu in his experiments [see Abstract No. 1666 (1900)] failed to observe both the magnetic effect of electric convection and its converse, the electrostatic effect of magnetic convection. The author discusses these experiments and maintains that Crémieu's failure is to be attributed rather to the methods employed than to the non-existence of these effects. He shows that in Crémieu's attempt to detect the electrostatic effect of a varying magnetic field, the effect of the steady magnetic field on the charging currents was left out of account, and that this latter effect is equal and opposite to the former; thus Crémieu's result really constitutes an indirect proof of the existence of such electrostatic effect, of the amount predicted theoretically. He also shows that Crémieu's experimental arrangements in repeating Rowland's experiment (Phil. Mag. 27, 1889, p. 445) were such as to cause the production of currents sufficient to compensate the desired effect, and that the partial failure when this disturbing factor was removed may be explained by the existence of defective insulation. [See also Abstract No. 1916 (1901).] W. C. H.

2139. *Magnetic Effect of Electric Convection and Crémieu's Experiments* **V. Crémieu.** (Phil. Mag. 2. pp. 235–237, Aug., 1901.)—This paper is a reply to H. Wilson's criticism of the author's experiments [see preceding Abstract]. Wilson's representation of the author's apparatus is stated to be inaccurate, as, instead of a vertical magnet, as shown, the author used a closed electromagnetic solenoid. This has zero external field, so that no electromagnetic effect on the charging current of the disc, such as Wilson suggests would be present, was possible. Wilson's second objection relates to the author's repetition of Rowland's experiment, and he suggests that insufficient insulation would account for the results. The author replies that the insulation of the parts concerned received special attention, and in further experiments, in which these parts have been completely suppressed, the same result has been obtained. He therefore abides by his former conclusions. W. C. H.

2140. *Magnetic Effect of Electric Convection.* **H. Pender.** (Phil. Mag. 2. pp. 179–208, Aug., 1901.)—After giving an account of Crémieu's experiments on this subject [see Abstracts Nos. 144 and 858 (1901)], and pointing out that the negative results of all his experiments may be due, either to the charge brushing off from the moving disc to the glass surface opposite, or from the condensing plates to the caoutchouc surface moving with the disc, the author describes the manner in which he has succeeded in observing the effect. The method employed, as in Crémieu's first experiment, consisted in measuring the current induced in a coil on reversing the convection current due to a charged rotating disc. By the use of micanite, instead of ebonite discs, change in the distance between the fixed and moving plates, due to their warping, was avoided. The author describes how the difficulties due to mechanical jarring, direct electrostatic effect, and outside magnetic disturbances, were overcome; and calculates the connection between the deflection of the galvanometer needle and v the ratio between the two electrical units of quantity. A series of experiments gave consistent results, the mean value of v determined from them being $3{\cdot}05 \times 10^{10}$. W. E. T.

2141. *Model of a Dielectric.* **J. A. Fleming** and **A. W. Ashton.** (Phil. Mag. 2. pp. 228–233, Aug., 1901. Paper read before the Phys. Soc. of London, May 31, 1901.)—An analogy to the charge and discharge of a condenser can be found in the behaviour of wires under mechanical stress, the stress corresponding to e.m.f., elongation of the wire to electric charge, and the rate of elongation to the charging or discharging current. A simple wire does not, however, give a complete representation of the effects, as it does not show clearly the effects of time in charging the condenser. The model described consists of a series of springs, attached to, and separating, a series of pistons, the ends of each spring being fastened to pistons, placed, one above the other, in a metal cylinder containing oil. The upper pistons are made to move more easily in the cylinder than those lower down. With this apparatus, compressed electrically by means of electromagnets at the upper end, the total compression depends not only upon the compressing force but also upon the time during which it acts. The compression is measured graphically on a revolving drum. The curves given show how nearly the model is capable of imitating the behaviour of the dielectric in the charging and discharging of a condenser. R. S. W.

2142. *Electrification of Dielectrics by Mechanical Strain.* **A. W. Ashton.** (Phil. Mag. 2. pp. 233–235, Aug., 1901. Paper read before the Phys. Soc. of London, May 31, 1901.)—A sheet of indiarubber is laid between two brass-plates, connected to the quadrants of an electrometer. When a 2-lb. weight is allowed to fall from a height of a few inches on to the upper brass-plate, the needle moves quickly to the right, but immediately returns and shows a steady deflection to the left. If the sheet is stretched, there is again a deflection to the right, showing that the top plate is negative, while, if the electrometer is discharged, and the sheet allowed to collapse, there is a deflection in the opposite direction, showing a difference of potential between the plates of more than 10 volts. R. S. W.

2143. *Terrestrial Origin of Auroræ.* **H. Stassano.** (Comptes Rendus, 133. pp. 279–281, July 29, 1901.)—With de la Rive, the author attributes the origin of the polar lights to the evaporation in the equatorial regions, and he relies on the statistics of Klein (northern polar lights) and Bollar (southern auroræ). The theory is not explained. Auroræ are very rare about the solstices, especially in July, and most frequent a little after the equinoxes, in April in the northern hemisphere, and in October in the southern; September and October are the driest months on the rainy Gulf of Guinea. In the northern hemisphere the number of auroræ averages more than thirty above lat. 60°; the corresponding line of the southern hemisphere, where climatic fluctuations are much more pronounced, keeps near the Tropic. The isothermals, isobars, and auroral frequency curves show a certain similarity, particularly in Alaska and Newfoundland. The complete paper will appear in the Annales de Géographie de Paris. H. B.

DISCHARGE AND OSCILLATIONS.

2144. *Electric Dispersion.* **A. Pochettino.** (Accad. Lincei, Atti, 10. pp. 104–109, Feb. 17, 1901; and N. Cimento, 1. pp. 453–457, June, 1901.)—Elster has found [see Abstract No. 629 (1901)] that as the relative humidity rises, the coefficient of dispersion of electricity in free air falls, whatever be the sign of the charge. This may be explained by assuming that when the aqueous vapour contained in the air is nearest to its point of condensation, a great number of the free ions existing in the air undergo a notable diminution in their mobility. These observations are important in the theory of the electric conductivity of gases, and in regard to the question of the existence of ions in ordinary air; and the author has found that the coefficients of dispersion are, within experimental errors, equal for both positive and negative charges (except on days of heavy precipitation). The nature of the ground on which the instruments are placed, or a difference in the surrounding objects, makes no difference in the value of the coefficient; and temperature, absolute humidity, force of wind, state of sky, or fall of potential appeared to produce no definite change in the value of the coefficient. In the fall of potential there were two characteristic maxima occurring at 11 a.m. and 4 p.m., and two sub-maxima at 9 a.m. and 1 p.m.; but there was nothing corresponding in the values of the coefficient of dispersion. Elster's result mentioned above is confirmed, and is general, being unaffected by the sign of the charge. During transitory showers the coefficient of dispersion rises for positive charges, and remains normal for negative charges; a result in harmony with those obtained by Elster and Geitel in the neighbourhood of waterfalls. A. D.

2145. *Diminution of Sparking Potential Difference by Magnetic Field.* **J. E. Almy.** (Cambridge Phil. Soc., Proc. 11. pp. 183–190, Aug. 10, 1901.)—It is known that a magnetic field, parallel or perpendicular to the direction of the discharge in a vacuum tube, may, if in the neighbourhood of the kathode, produce a diminution in the voltage required to produce the discharge. There is certain critical intensity of the field for which this diminution is very large. The effect is not produced at relatively high pressure; it has a very close connection with the form of the discharge. Surrounding the tube with tin-foil produces the same fall in voltage as does the magnet, when the foil is absent, but when the foil is present the magnet has no effect. When the anode surrounds the kathode similar, but more marked, results are obtained, so that the influence of the field is not due to a static charge on the walls of the tube, but is apparently dependent on the concentration of the current into a kind of brush, or arc, discharge. R. S. W.

2146. *Free Ions in the Atmosphere.* **H. Ebert.** (Archives des Sciences, 12. pp. 97–117, Aug., 1901.)—Experiments were made with an electrometer of the Elster and Geitel pattern, and with a more portable instrument of the author's. A long horizontal tube serving as a screen is fixed to the neck of the electrometer; it contains another tube resting on the electrometer rod and called the tension tube. Through this tube, air is drawn by an Assmann psychrometer, or by other means, with a velocity of from 3 to 6 cm./sec. The tension tube is charged to a potential of 200 volts. The electrometer was found to remain charged for several days after stopping the air current. The number of free ions in the air seems to increase with the purity and transparency of the air and the intensity of the solar radiation; both the number of free ions and their velocity of discharge vary considerably. As regards the higher strata, see Abstract No. 1917 (1901). H. B.

2147. *Dependence of Current in Gases on the Direction of the Electric Field.* **E. Rutherford.** (Phil. Mag. 2. pp. 210–228, Aug., 1901.)—It has generally been assumed that the magnitude of the current between two electrodes placed in an ionised gas is independent of the direction of the electric field, except for very small potential differences. The author shows that several conditions must be satisfied for this to hold good, and gives various experimental arrangements for studying the inequalities of the currents in the two directions. The essential conditions for obtaining unequal currents are—(1) An ionisation unsymmetrical with regard to the electrodes. (2) A disturbance of the potential gradient, due to the movement of the ions in the electric field. (3) An unequal velocity of the ions. Under these conditions the ratio of the currents between the electrodes is the same as the ratio of the velocities of the ions. The experimental arrangement given ought, therefore, to prove capable of determining the ratio of these velocities. It is found, however, that the large secondary radiation from the ionised air prevents the fulfilment of the theoretical conditions required for the calculation. Anything, such as the presence of moisture, which renders the velocities of the ions more equal, should reduce the ratio of the currents in the two directions. This is found to be the case. R. S. W.

2148. *Dielectric Cohesion of Gases.* **E. Bouty.** (Comptes Rendus, 133. pp. 213–215, July 22, 1901.)—The dielectric gas allows electricity to pass when the electrostatic field passes a certain limit. The present inquiry is as to the influence of the dielectric wall. The thickness of this wall affects the strength of the field within the flask, but the nature of the material in contact with the gas has no influence upon the strength of field required to break down the dielectric cohesion. [See also Abstracts Nos. 2443 (1900) and 860 and 1318 (1901).] A. D.

2149. *Reflection and Absorption of Kathode Rays.* **W. Seitz.** (Ann. d. Physik, 6. 1. pp. 1–33, Aug., 1901.)—When kathode rays pass through metals it may be supposed that the electrons forming the stream travel through the inter-molecular spaces, impinging on the molecules of the metal, and that, in consequence of these collisions, some are diffusely reflected back into the air, while of the remainder some are absorbed on account of their reduced velocity and others transmitted. To test this view the author especially studies the diffusion of the rays under different angles of incidence and emission, and tests the validity of Lenard's law of absorption, according to which the magnitude of the absorption is proportional to the amount of matter traversed by the electrons. The results are as follows: With perpendicular incidence the intensity of the diffused rays decreases, and is approximately proportional to the cosine of the angle of emission. With greater angles of incidence the metals behave differently from each other. Aluminium, zinc, iron, and copper give the maximum intensity in a direction making an angle of about 20° with the normal, and lying on the same side of it as if they were regularly reflected; with platinum, silver, and gold the maximum is found in a direction between the normal and the incident rays. For the former class the reflection increases with the angle of incidence, for the latter it somewhat decreases. With perpendicular incidence the reflection increases with the atomic weight, except in the case of zinc. The absorption of the rays by thin plates of metal is largely dependent on the voltage which produces them; contrary to Lenard's law, it *increases* with the thickness of the plate; the law is therefore only a first approximation. The increase of the absorption coefficient with the thickness of the sheet cannot be explained on the supposition that, by friction with the molecules, the electrons lose their velocity, and are therefore more easily absorbed; for the deflection of the rays by an electrostatic and also by a magnetic field, both before entering and after passing through the plate, is measured, and is found to be the same for both positions. The values of the velocity and of the ratio of the mass to the electric charge agree with Lenard's determination. R. S. W.

2150. *Magnetic Deflection of Kathode Rays.* **H. A. Wilson.** (Cambridge Phil. Soc., Proc. 11. pp. 179–182, Aug. 10, 1901.)—The object of these experiments was to prove, more completely than had hitherto been done, that the ratio of the charge carried by a kathode ray particle to its mass is independent of the nature of the metal of which the kathode is composed. Strips of different metals, fastened over holes in a strip of mica, serve in turn for kathodes. They can be brought into position, and in contact with a movable wire going to the exterior, by means of an electromagnet. The beam of kathode rays so obtained is deflected by the magnetic field due to a constant current in a coil of wire. If the current in the coil is known, the deflection of the rays, and the potential difference producing the discharge, the ratio required can be found. The result shows that this is independent of the nature of the kathode. R. S. W.

2151. *Hertz Resonators.* **A. Turpain.** (Journ. de Physique, 10. pp. 425–438, July, 1901.)—If we have a resonator in a Hertzian field concentrated by two parallel wires, we must, in order to make the resonator alternately act and be extinguished, either move the resonator to and fro with its plane parallel to the plane of the two wires, or rotate it round its own centre in its own plane. At the micrometer-gap it is agreed that there is a node of stationary waves at each free end, and a loop at the opposite mid-point of the resonator; and the wave-length to which the resonator responds in twice the length of the resonator. But as there are two extinctions and two maxima in a rotation of the resonator through 360° in its own plane, it would seem that there were four concamerations in the complete circle; and if there are four equidistant micrometer-gaps in a resonator, when two of these, opposite to one another, give a maximum spark the other two give none. The author showed in 1895 that a resonator with a hiatus in it in addition to a micrometer-gap worked as easily as a complete resonator. The hiatus plays the same part as the micrometer in a complete resonator; and the spark in the micrometer-gap is greater the greater its distance from the hiatus: whence it would follow that there are nodes at the hiatus. But as the hiatus is diminished until a spark crosses it, it is found that the spark is then of the same length as the maximum spark which the micrometer-gap would have given: in which case there would appear to be loops, not nodes, at the hiatus. This needed further investigation. If a resonator be enclosed (except the micrometer-gap) in rarefied air, the luminescence of this air shows the local electric conditions of the resonator. The rarefaction must be adjusted so as to prevent the concentrating wires from themselves producing luminescence. The smaller the micrometer-spark, the more nearly is the luminescence confined to its immediate vicinity: when it is at its maximum, the luminescence may extend from 120° to 150° to each side of it; and as the spark is being reduced or extinguished by turning the resonator, the luminescence shrinks or disappears. If a resonator with a hiatus be used in a similar way, there is a glow at the hiatus which shrinks and fades as the micrometer-spark is lengthened and disappears when this ceases, and also shrinks and fades as the resonator is turned round so as to bring the hiatus into the extinction positions. In a resonator with two micrometer-gaps at 180° to one another, these will act as hiatus and micrometer-gap indifferently, and if equal, even alternately; the gap which happens for the moment to offer the greater resistance acts as the hiatus, and at that gap the glow is seen. This glow is evidence that at the gap of greater resistance there are two *nodes* of opposite signs, at which the variations of electric density are at a maximum. The author has extended this method of research, by means of the glow in rarefied air, to the whole Hertzian field. He describes the apparatus employed. A. D.

2152. *Hertzian Waves in Storms.* **F. Larroque.** (Comptes Rendus, 133. p. 36, July 1, 1901.)—The author, led to the subject by considering the way in which certain nervous invalids feel the approach of a storm even under a clear sky, thought this might be due to Hertzian waves propagated through the middle and upper atmosphere. A simple plate of zinc, 40 cm. square, put to earth through a micrometric spark-gap, was sufficient to show the existence of such waves prior to a storm, even under a clear sky, in two notable instances in June last. The storm was actually raging at the time of observation, in the one case in the Grampians of Scotland, and in the other case among the Maritime Alps. A. D.

2153. *Oscillatory Discharges through Divided Circuits.* **T. Mizuno.** (Electrician, 47. pp. 711–713, Aug. 30, 1901.)—A mathematical article treating the case of the oscillatory discharge of a condenser through two inductive circuits in parallel. The following results are obtained: (1) In general, the current does not take a simple form, as in the case of oscillatory discharges in a single inductive circuit. But, if the time-constants of the divided circuits happen to be equal, then the circuits may be reduced to a single equivalent inductive circuit, giving rise, under a certain special condition, to simple harmonic discharge currents. (2) Each inductive circuit has its own period of oscillation, depending on its resistance and inductance, and on the capacity of the condenser. E. H. B.

2154. *Influence of Non-inductive Resistance on Oscillatory Discharge.* **T. Mizuno.** (Ann. d. Physik, 4. 4. pp. 811–814, April, 1901, and Electrician, 47. pp. 169–171, May 24, 1901.)—When a non-inductive resistance S is placed in parallel with a resistance R, through which a condenser is discharging itself, the author shows that this is equivalent to increasing R to $R + L/SC$, L being the self-induction in R, and diminishing the capacity C of the condenser to the value $C\frac{S}{R+S}$. The damping of the oscillations is increased, and the more the smaller S. If S is smaller than the limiting value required to satisfy the inequality—

$$\left(\frac{4L}{C} - R^2\right)C^2S^2 + 2LRCS > L^2,$$

then the discharge becomes aperiodic. The non-inductive resistance thus offers an easy means of varying the period of discharge.

In the Electrician the above is repeated, and it is further proved that the frequency is a maximum when S = L/CR, and that the ratio of the maximum frequency of oscillations in the inductive circuit with the non-inductive coil in, to the given frequency without the coil, is

$$\sqrt{1 + R^2/E}, \text{ where } E = 4L/C - R^2.$$

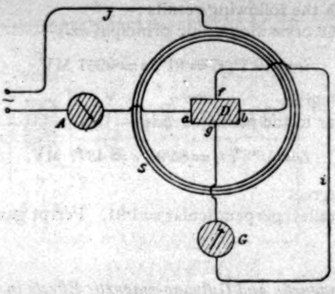
Two curves are given showing the variation of frequency with S, and of the equivalent resistance with S. G. E. A.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2155. *Dielectric Losses.* **C. P. Steinmetz.** (Elect. World and Engineer, 37. 1065–1066, June 22, 1901.)—The author determined the dielectric loss in condensers of tin-foil and paraffined paper, at various frequencies and voltages. He does not consider it possible to accurately measure the loss by a wattmeter, as, when the instrument is fully loaded, the reading will be very small, and it is difficult to avoid errors due to self-induction or capacity. The method adopted was to place, first in parallel and then in series with the condenser, an inductive coil, in resonance with it; in the first case the resultant current is small and practically in phase with the pressure; in the second case the resultant voltage is small and in phase with the current. In either case then, a wattmeter can accurately measure the loss in the condenser and inductive coil; non-ohmic loss in the latter was avoided by constructing it without iron, and with stranded conductors. The loss in it could therefore be measured by direct current. The following are the results obtained:—(1) With sine-wave current, the condenser current is proportional to the voltage (between 220 and 980 volts), and to the frequency. (2) The power-factor of the condenser is independent of the voltage and of the frequency. (3) The power-factor of the condensers tested averaged 0·005. The author considers the loss mainly due to traces of air occluded in the dielectric, and caused by mechanical motion of the air molecules. G. H. B.

2156. *Hall's Phenomenon in, and Resistance of, Bismuth.* **E. van Everdingen, Jr.** (Archives des Sciences, 11. pp. 433–448, 1901.)—The author's experiments were made on bars cut in different directions from the prism of crystallised bismuth employed by Perrot in his researches (Archives, vi., Aug., 1898) [Abstract No. 104 (1899)]. His conclusions are as follows: Hall's coefficient is large for a field perpendicular to the principal axis of the crystal, and very small (sometimes positive) for a field parallel to the axis; for fields of 4,600 and 2,600 units the value of the coefficient is, respectively, $-8·2$ and $-10·6$ perpendicular to the axis, and $+0·6$ and $-0·1$ parallel to the axis. The values for other directions of the field are given by the radius vector of an ellipsoid, in a way described in the paper, and showing close agreement with experiment. As regards the resistance of bismuth, when not in a magnetic field, the conductivity in any direction is proportional to the square root of the radius vector of an ellipsoid of revolution round the principal axis of the crystal, the axes being in the ratio of $\sqrt{5} : \sqrt{3}$ approximately. In a magnetic field parallel to the axis an ellipsoid with but slightly different axes gives the conductivity. In a field perpendicular to the principal axis of the crystal the three axes of the ellipsoid are different, and have values differing considerably from those of the corresponding ellipsoid with no field. The author further shows how an ellipsoid may be constructed to give the conductivity for a magnetic field of any direction. In a plate of bismuth the resistances in two directions at right angles are not increased in the same ratio by the same field—a fact which explains the dissymmetry shown in Hall's phenomenon. G. H. B.

2157. *Conversion of Alternating into Continuous Current by Means of the Hall-Effect.* **T. des Coudres.** (Phys. Zeitschr. 2. pp. 586–590, July 6, 1901.) —The principle of the method is illustrated by the following diagram :—



The alternating current is sent through the coil S and also through the thin bismuth plate D. When this is done, the d'Arsonval galvanometer G in connection with the Hall electrodes *f* and *g* indicates a continuous current. It is obvious that this must be so, since the primary current and magnetic field change sign simultaneously. The author proves that the method is of no technical value, but is of opinion that it might come in useful for the determination of Hall constants. He also shows how the above arrangement might be used as a dynamometer, and as a direct harmonic analyser of alternating magnetic fields. F. G. D.

2158. *Thermo-magnetic and Thermo-electric Behaviour of Crystalline Bismuth.* **L. Lownds.** (Ann. d. Physik, 6. 1. pp. 146–162, Aug., 1901.) —A continuation of earlier experiments [see Abstract No. 1680 (1901)] on this subject is described. Groth, having furnished the author with a plate formed out of a large crystal of bismuth in which the crystallographic principal axis lay in the plane of the plate, an account is given of the investigations carried out with this.

I. As regards the *longitudinal effect*, it appears (1) that the curves showing the connection between the intensity of field and the longitudinal effect are of similar form for crystalline and for electrolytic bismuth, but in the former case the negative values hold with much higher temperatures. (2) In the case in which both the flow of heat and the lines of force are perpendicular to the crystallographic principal axis, positive values of the longitudinal effect exist only with the highest temperatures, and with very small intensities of field.

II. The curves relating to the *transversal effect* show that this is smaller when the flow of heat is parallel to the principal axis than when perpendicular. Whilst Yamaguchi found that with electrolytic bismuth the transversal effect continually increased with falling temperature, with crystalline bismuth it is found that in strong fields, and at very low temperatures, the effect falls off with decreasing temperature.

III. As to the *thermo-electromotive force;* this was observed for a copper bismuth couple, the temperature differences being measured by an iron-constantan element. The formula for the e.m.f. e (in microvolts) is—

$$e = \alpha (t_1 - t_2) + \beta (t_1^2 - t_2^2),$$

where t_1 and t_2 are the temperatures of the junctions in centigrade degrees, and α and β are constants.

Measurements were made parallel and perpendicular to the principal axis of the bismuth, with the following results :—

(1) Parallel to the crystallographic principal axis—

$$t_1 = 12{\cdot}7^\circ,\ t_2 = 91^\circ,\ e = 9267 \text{ MV},$$

or 118·35 MV per degree.

(2) Perpendicular to the principal axis—

$$t_1 = 15{\cdot}3^\circ,\ t_2 = 85{\cdot}9^\circ,\ e = 4377 \text{ MV},$$

or 61·94 MV per degree.

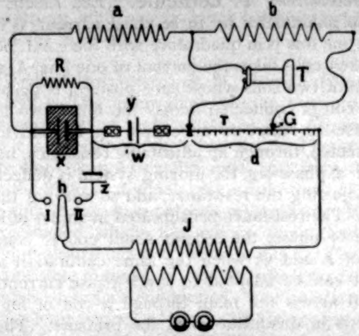
The ratio of parallel/perpendicular = 1·91. Perrot gave the value of this ratio as about 2·00. J. J. S.

2159. *Thermo-magnetic and Galvano-magnetic Effects in Tellurium.* **M. G. Lloyd.** (Amer. Journ. Sci. 12. pp. 57–63, July, 1901.)—The author gives the qualitative results of some experiments made with the idea of measuring all of the thermo-magnetic and galvano-magnetic effects in the same specimen of a non-metal, tellurium being the substance chosen. The Hall-effect is in the opposite direction from that observed in bismuth; the galvano-magnetic difference of temperature between the edges of the plate carrying the current is in the same direction as in bismuth. When, instead of a current of electricity, a flow of heat is made to pass along the plate placed in a magnetic field perpendicular to the lines of force, the thermo-magnetic difference of potential observed between the edges is in the same direction as in bismuth, while the difference of temperature between the edges is in the reverse direction to that in bismuth. Satisfactory numerical determinations of most of these effects have not yet been obtained. W. C. H.

2160. *Electric Deformation of Glass.* **G. Ercolini.** (N. Cimento, 2. pp. 5–15, July, 1901.)—This paper contains a discussion of questions of energy and thermo-dynamics, and a description of the author's experiments. He obtains a positive value for k, *i.e.*, the dielectric constant of glass increases with the tractive stress. H. D.

2161. *New Method of Localising a Fault in a Single Cable.* **W. Betts.** (Elect. Rev. 49. pp. 255–256, Aug. 16, 1901.)—Batteries of equal, or nearly equal e.m.f., of the same kind, and of low voltage, are simultaneously applied at each end of the cable, the batteries being earthed, and the current going through the fault. Observations are numbered in order, and paired for calculation. Then, if L be the normal CR of the cable, and r and r' represent the resistances of the galvanometer, battery, and earth at the two ends respectively, and if a and b are the resistances required to represent the deflection at either end respectively, then the distances of the fault at either end will be $\mathrm{L}a/(a+b) - r$ and $\mathrm{L}b/(a+b) - r$, respectively. Very good results are said to be attained by this method. E. O. W.

2162. *Measurement of Accumulator Resistance.* **T. Bruger.** (Centralblatt Accumulatoren, 2. pp. 197–198, July 15, 1901.)—The method originally designed by Kohlrausch has been modified in a number of ways. The use of condensers [see Abstract No. 857 (1901)], adopted by several experimenters, has been avoided by the author in the arrangement shown. Here *a* and *b* are non-inductive resistances, *x* is the accumulator to be measured, which is being discharged through the resistance R, *y* and *z* are two other cells,



d a graduated bridge wire, *h* a two-way switch, J the induction coil, and T a telephone. A balance is first obtained in the I position of the switch, then—since R is large compared with *x*—

$$a/b = (x + w)/r_1 \text{..............................}(1)$$

w being the resistance of *y*, and r_1 that of the bridge wire between G and the end to which the telephone is connected. The switch is now thrown over to the II position, and a second balance gives—

$$(x + a)/b = w/r_2 \text{ ....}(2)$$

Hence—

$$x = a(r_1 - r_2)/(b + r_2) \text{ ....}(3)$$

Since *a* and *b* are usually large compared with *r*, sufficient exactness is given by—

$$x = a(r_1 - r_2)/b \text{ ....}(4)$$

If desired, the method may be modified by moving the telephone contact so as to include a portion of the bridge wire in the *w* circuit.

A bridge constructed by Hartmann and Braun is convenient for making the measurements. W. W. H. G.

2163. *Electroscope.* **Hurmuzescu.** (Annal. Sci. de l'Univ. de Jassy, 1. pp. 326–328, March, 1901.)—The electroscope has three metal sheets 2 millimetres apart; on the outer two are hung two gold leaves. Beneath these three sheets, and in electrical communication with the case of the electroscope, are two similar sheets, which can be moved up between the three sheets so as to form a condenser, or moved away from them. When the electroscope is to be charged, the two sheets are moved up, so that the capacity of the electroscope is large; then, if the voltage be too feeble to diverge the leaves, the two sheets are lowered, diminishing the capacity and increasing the pressure till the leaves diverge. G. H. B.

2164. *Feussner's Potentiometer.* **O. Wolff.** (Zeitschr. Instrumentenk. 21. pp. 227–231, Aug., 1901.)—The author describes an improved form of Feussner's potentiometer constructed by him, with dial switches to replace the plug switches. The dials are made with twenty segments in two series, the switch inserting resistance in one series as it cuts it out from the other. G. H. B.

2165. *Holden Phasemeter.* **P. Letheule.** (Ecl. Electr. 28. pp. 183–185, Aug. 3, 1901.)—The phasemeter for three-phase currents is based on the fact that the current in one line is in quadrature with the e.m.f. between the other two. A pair of fixed coils takes the current of one line, A, and in their field is a moving system of two coils whose zero position is perpendicular to the series coils. One coil is connected across the other two lines, B and C, so that, with no phase-lag, there is no couple on the moving system. The second coil is connected, through an adjustable resistance, between A and C; when, by reason of a phase-lag, the moving system is deflected, it is brought back to zero by adjusting the resistance, and so varying the couple on the second shunt coil. The resistance is calibrated in angles of lag. To measure angles of advance of phase, the second shunt coil is connected between A and B instead of A and C, when the same calibration applies.

The instrument can be adapted to single-phase currents by connecting the first shunt coil across the main through a coil of high self-induction, so that its current is in quadrature with the pressure. The deflection produced by a phase-lag is annulled by shunting the inductive coil by an adjustable non-inductive resistance, which can be calibrated in angles of phase. The effect of variations in frequency may be compensated by connecting the second shunt coil across the main through a condenser of suitable capacity. G. H. B.

2166. *Frequency Meter.* **R. Manzetti.** (Accad. Lincei, Atti, 10. pp. 157–168, 1901.)—The instrument has a moving system consisting of a copper disc, and a parallelopiped of laminated iron, rigidly connected one above the other, and suspended by a silk fibre; each is acted on by an independent pair of coils. The two pairs of coils are connected in parallel across the circuit with an adjustable resistance in series with one pair. The torque exerted on the iron is independent of the frequency, while that on the copper, being due to Foucault currents, is a function of it. If then the two pairs of coils be so adjusted that for any given frequency the torques exerted by them are equal and opposite, there will be no deflection, but for a different value of the frequency a deflection will be produced, which can be annulled by adjusting the resistance in series with one pair.

If the resistances be r and r_1, and the frequency p, the author shows that $\frac{r_1^2}{r^2} = \frac{a + bp^2 + cp^4}{p^2 + dp^4}$. The measurement of the frequency is thus reduced to a zero adjustment of the instrument, and a measurement of a resistance ratio. In tests made by the author, the instrument proved correct within the limits of accuracy with which he was able to determine the frequency. The instrument can measure very low frequencies, but its readings might be falsified by self-induction at high ones. G. H. B.

2167. *Conductivity Bridge.* **R. Appleyard.** (Phil. Mag. 2. pp. 178–179, Aug., 1901. Paper read before the Phys. Soc. of London, March 8, 1901.) —The bridge is arranged so that the scale-readings on the slide-wire are directly proportional to the conductivity of the wire under test. When used for comparing the conductivities of two lengths of wire, the arrangement is as follows: the two lengths form two adjoining arms, with the galvanometer connected to their junction; a fixed resistance and the slide-wire form the other two arms; the end of the fixed resistance being connected, not to the end of the slide-wire, but, together with the other galvanometer terminal, to the sliding contact. The author finds the best sliding contact to be a small brass bow, strung with one or more platinum wires, each of which passes once round the slide-wire. G. H. B.

2168. *High Electrical Resistance.* **O. N. Rood.** (Amer. Journ. Sci. 12. pp. 91–97, Aug., 1901.)—The author describes the continuation of his experiments on the measurement of high resistance [see Abstract No. 110 (1901], and explains how it is possible to take a low standard resistance, measured by ordinary methods employing 50 or 100 volts, and from this to build up a set of resistances, the highest of which may equal fifteen or twenty millions of megohms, the original e.m.f. being always adhered to. With such units of resistance, any resistance which lies within their range may be easily measured, employing always one and the same e.m.f. The cores of the units described are inaccessible to moisture, and in ordinary weather their accuracy is not interfered with by surface conduction. The question of the invariabilty of the units during long periods of time is still under investigation. Details of the construction of the electrometer (similar to that already described in the former paper), of the condensers, and of the units of resistance, are given in the paper. J. J. S.

2169. *Rectifier for Polyphase Currents.* **L. H. Haynes.** (West. Electn. 29. pp. 99–100, Aug. 17, 1901.)—This paper contains a description of an experimental rectifier for use on a two-phase circuit. Each phase is rectified individually by its own two-part commutator, and the two circuits are connected in series on the direct-current side. The phases are short-circuited when the e.m.f. passes through zero, the time of short-circuit being capable of adjustment by means of a second brush. B. P. S.

ALTERNATING CURRENTS AND MAGNETISM.

2170. *Approximate Power Measurement in Three-phase Circuits.* **G. Stern.** (Elektrotechn. Zeitschr. 22. pp. 577–580, July 18, 1901.)—The author discusses the errors to which certain forms of three-phase supply meters are subject, and gives a full theoretical discussion of one recently patented device. He points out that none of the meters whose construction depends on equality of the three p.d.'s are reliable, and that the power in an unbalanced three-phase circuit can only be satisfactorily measured by means of at least two instruments. A. H.

2171. *Power Measurement in Polyphase Circuits.* **J. A. Fleming.** (Electrician, 47. pp. 407–409, July 5, 1901.)—The ways of measuring power in polyphase circuits by means of wattmeters are first described. Various methods are then given of finding the power expended in a mesh-connected three-phase system. An extremely simple solution is given of the problem of finding the currents in a mesh connection when the currents in the mains are known. If A, B and C are the effective currents in the mains, and X, Y and Z those in the delta branches, then if the latter have equal phase differences we have to solve the following equations in order to find X, Y and Z in terms of A, B and C:—

$$X^2 + XY + Y^2 = A^2,$$
$$Y^2 + YZ + Z^2 = B^2,$$
$$Z^2 + ZX + X^2 = C^2.$$

Instead of solving the equations algebraically the author draws three lines from a point 0 making angles of 120° with each other, and then constructs a triangle whose sides are A, B and C on tracing paper. Placing the tracing paper over the other, the line A is moved about with its ends on two of the lines until the vertex of the triangle lies on the other line. When this is the case, the lines from 0 to the vertices of the triangle give X, Y and Z in magnitude and phase. A. R.

2172. *Alternating Current and Power Wave Recorders.* **É. Hospitalier.** (Soc. Int. Élect., Bull. 1. pp. 339–358, July, 1901. Also Ind. Élect. 10. pp. 295–300, July 10; and 323–326, July 25, 1901.)—Various novel applications of stroboscopic methods to the study of alternating currents are first given. A. Samojloff has noticed that the light from an ordinary glow-lamp with a fine filament on an alternating current circuit fluctuates with a frequency which is double that of the current. The experiment can easily be repeated with a teetotum made of a disc of carboard mounted on a cork with a pointed wooden match for a spindle. The disc has three white and three black sectors. When spinning rapidly it appears gray, as it slows down the sectors appear to rotate, then become stationary, the rotation then reverses, after which the disc again appears gray. A similar method is employed to determine the slip of an asynchronous motor, a card with white and black sectors on it being fixed on the axis of the rotor and illuminated by a glow-lamp on the supply circuit. The apparent angular velocity of the sectors is equal to the slip. The "Arcoscope" is an instrument perfected by the author for studying the variations in the light of the alternating current arc. By means of a circular metal disc with slots in it driven by an asynchronous motor, he shows all the variations in the light of the arc taking place during a period of fifteen seconds. The "ondograph or cymatograph" is an instrument that gives a record drawn in ink of the shape of an alternating current wave. It is not as accurate as the oscillograph, but it gives a permanent record very rapidly, and is not easily damaged. Its principle is not unlike that of the Laws recorder [see Abstract No. 1126 (1901)]; but instead of the brushes being made to move uniformly round a contact wheel, a commutator is coupled to a synchronous motor in such a manner that when the motor makes n revolutions the commutator makes $n-1$. No photography is used, and the wave is recorded on paper coiled on a Kelvin rotating cylinder. A complete curve with a base 9·6 cms. long can be traced out in fifteen seconds; hence a useful record of the phenomena that happen over a period of fifteen minutes can be recorded on a band of paper 6 metres long. A novel instrument described is the "electrodynamograph," or power wave recorder. It is similar to an Elihu Thomson watt-hour meter, mounted as a wattmeter. The brushes are suppressed, the current being led to the armature by two spiral springs, which also control its position. The series coil always carries the main current, but the p.d. is only applied across the armature at momentary intervals. The angular displacement of the armature is proportional to the power at any instant, and its maximum value is about 10 degrees. The pen of the recorder is controlled by the armature. Power curves traced by the instrument are given. A. R.

2173. *Phase-turning Apparatus.* **A. Campbell.** (Phys. Soc., Proc. 17. pp. 607–608, July, 1901 (Abstract).)—When a small voltage is to be measured on an electrostatic voltmeter, it is often convenient to add to it a known voltage, so as to bring the deflection to an open part of the scale. In the case of alternate currents, the added voltage must be in phase with that to be measured, and the arrangement enables the phase of the added voltage to be turned till this condition is realised. G. H. B.

2174. *Duality in Electrical Theory.* **H. Sire de Vilar.** (Écl. Électr. 28. pp. 236–250, Aug. 17, 1901.)—In this paper the author extends the principle of duality [see Abstract No. 1666 (1901)] to the theory of alternating currents. The ordinary equation to an inductive circuit is—

$$e = Ri + L\frac{di}{dt}.$$

Assuming that e is a sine wave, it easily follows that—

$$i = Ke + C\frac{de}{dt},$$

where $K = R/(R^2 + L^2\omega^2)$ and $C = -L/(R^2 + L^2\omega^2)$, ω being written for 2π times the frequency. The author calls K the fictitious conductance and C the fictitious capacity of a circuit. The impedance (M) is $\sqrt{R^2 + L^2\omega^2}$, and the imaginary impedance (M′) is $R + L\omega\sqrt{-1}$. The reciprocal (N) of the impedance is $\sqrt{K^2 + C^2\omega^2}$ and the reciprocal (N′) of M′ is $K + C\omega\sqrt{-1}$. We always have $N = 1/M$ and $N' = 1/M'$. Employing the same notation as in Abstract No. 1666, we get—

$$e_1 + e + \quad Ri + L\frac{di}{dt}\Big) \qquad = 0,$$

or for sine curves— $$e_1 + e + \left(R + L\omega\sqrt{-1}\right)i = 0,$$

i.e.— $$e_1 + e + M'i = 0 \quad\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The reciprocal of this equation is—

$$i_1 + i + N'e = 0 \quad\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Hence the equations are of the same form as for direct currents. The vector diagrams of equations (1) and (2) are triangles. The watts in an alternating current circuit are given by the equation—

$$\frac{1}{T}\int_0^T e\,i\,dt = VA\cos\phi,$$

where ϕ is the phase difference between e and i, and V and A are their effective values. If ϕ is an acute angle, the power is positive; if a right angle, it is zero; and if obtuse, the power is negative. Eliminating M′ and N′ between equations (1) and (2), we get—

$$e_1 i_1 + e_1 i + e i_1 = 0.$$

A rule is deduced for distinguishing whether the circuit is acting as a generator or as a motor. The reciprocal relations between motor and generator circuits are given, and it is shown that every theorem proved for an electrical circuit has a correlative theorem in the reciprocal circuit. For example, a circuit in which the e.m.f. is constant has for its reciprocal a circuit in which the p.d. is constant. An example is fully worked out. The characteristic curves are drawn by the bipolar method which Blondel also employs [see Abstract No. 1127 (1901)]. A. R.

2175. *Effect of Magnetisation on Young's Modulus.* **K. Tangl.** (Ann. d. Physik, 6. 1. pp. 34–64, Aug., 1901. From a paper read before the Ungar. Akad. Wiss. Jan. 22, and May 21, 1900.)—The basis of the author's method of experiment is as follows: If a wire is magnetised under constant stretching force, it alters its length; if it is magnetised, on the other hand, so that its length remains constant, then the stretching force alters. The ratio of the two alterations is proportional to the elasticity-modulus for the chosen magnetisation. The author used thin wires of about 0·1 mm. diameter. The wires were stretched vertically, and a bifilar suspension was employed, consisting usually of platinum wires 60 cm. long, with small cross-pieces every 2 cm. Variation of length of the wire or of stretching force was indicated by the torsion of the suspension, and the method by which, in either case, the original equilibrium was restored gave the actual measure of the particular variation. These detailed arrangements are fully described. With nickel wire Young's modulus rises with the magnetising force, increasing by 1·5 per cent. as the force rises from 160 to 470 c.g.s. units. For iron the modulus is a maximum for H = 286 c.g.s. units, decreasing for stronger magnetisation. The stretching forces, however, in these experiments were small, and as the results are contrary to those of some other experimenters, the author investigated further the effect of the stretching force, using forces from 75 to 900 grammes. He finds that the effect of magnetisation on Young's modulus depends greatly on the stretching forces used, and upon the previous history (as regards stretching) of the wire. W. C. H.

2176. *Change in Steel Magnets. I.* **I. Klemenčič.** (Ann. d. Physik, 6. 1. pp. 181–191, Aug., 1901.)—The author measured the loss of magnetic moment with time in steel-bar magnets. Bars of silver steel were hardened in water at a white heat, and, after a certain number of minutes, T were magnetised; the moments were measured at different times, *t*, after magnetising. The loss of moment is less, the longer T is; for T = 1, the loss after 119 minutes was 11·5 per cent., for T = 60, the loss was 2·2 per cent. If, however, *t* be reckoned from the time of hardening and not from that of magnetising, the rate of loss of moment for any value of *t* is approximately independent of T. This tends to show that the loss of moment is due to after-effects of the hardening, and not, except to a small degree, to those of the magnetising. The rate of loss of moment is rapid at first, and gradually diminishes.

The percentage loss is less the greater the ratio of the length to the diameter of the bar. The rate of loss is different in different kinds of steel, and the form of the curve of moments and time is different. In unhardened steel, or in steel hardened at a low red heat, there is no perceptible loss of moment. In steel hardened at a bright red heat, though the moment acquired is only slightly greater, the loss after 49 minutes was 4 per cent. There appears, therefore, to be a critical point in the temperature of hardening, below which the moment remains constant. The after-effects of hardening are hastened, but not changed, by heating at 100°C. A bar, magnetised one minute after hardening, had a moment represented by 937·5; after 8 hours' heating the moment was 588·5, and showed no decrease after 48 hours. A second similar bar was heated for 8 hours after hardening, and then magnetised; the moment was 907·5, and showed a decrease of about ¼ per cent. after 48 hours, attributed by the author to after-effects of magnetisation. G. H. B.

2177. *Magnetic Properties of New Kinds of Iron.* **E. Gumlich** and **E. Schmidt.** (Elektrotechn. Zeitschr. 22. pp. 691–698, Aug. 29, 1901. Communicated by the Physikalisch-Technische Reichsanstalt.)—Measurements were made on ellipsoids by the magnetometric method, and also on bars by the yoke-method. The effect of repeated annealing was tried, the specimens being heated to about 950° C. in the furnaces of the Royal Porcelain Manufactory, and allowed to cool for three days. In Walz-iron, a very pure and soft material, the annealing had but little effect. In cast-iron, however, the effect is very marked, and is reached in one annealing; the coercive force is reduced in some cases to one-third, the hysteresis to one-half; repeated annealing diminishes rather than increases the effect. In steel the effect of annealing was very varied, depending on the quality of the steel. In dynamo sheet-iron, the first annealing improved the magnetic properties, while a second had the opposite effect. This iron was found to be very sensitive to mechanical handling; cleaning off the oxidised surface by emery cloth was sufficient to increase the energy loss by 26 per cent. From this the authors think it probable that the magnetic properties of iron when built up into an armature are inferior to those of the sheet when tested previously. Experiments on a 3 cm. steel rod showed that the effect of one annealing did not penetrate to the axis. Measurements of the electrical resistance of different irons showed that in general this was higher the higher the hysteresis loss, and the less the maximum permeability; this does not, however, apply in individual cases. A certain iron, of secret composition, which was submitted for test, had three times the average resistance of other irons, while showing a large permeability and low hysteresis loss.

Details are given of the methods employed in measuring the different quantities; and very complete tables of values for many different sorts of iron and steel. The following is a summary of some of the results:

Material.	B for H = 100.	B residual.	Coercive Force.	Max. μ	Hysteresis Loss (ergs).
Remscheider Dynamo steel...	17,600	8,840	1·27	3,280	12,800
Gelsenkirchener cast-steel ...	17,700	8,500	1·63	2,630	13,300
Böhler Tungsten steel	15,700	12,900	16·7	433	92,000
Remscheider Tungsten steel...	14,400	9,880	27·5	233	116,000
Kohlswa (52)	17,460	8,520	1·66	2,390	16,200
„ (50)	17,280	8,800	2·08	2,060	22,000
Walz-iron..........................	17,300	8,060	0·67	4,640	5,160
„ annealed	17,270	8,650	0·69	6,050	5,070
Cast-iron	8,800	4,630	13·2	200	36,600
„ annealed	9,600	5,060	4·68	560	16,100

G. H. B.

2178. *Hysteresis Measurement.* **G. Finzi.** (Elettricità, Milan, 20. pp. 856–858, June 8, 1901.)—The method of measurement is based on the assumption that, after magnetic saturation, the hysteresis of soft iron is proportional to its coercive force. The specimen may be of any dimensions provided it can pass into the magnetising solenoid; it is magnetised till practically saturated, and the current diminished to zero and then reversed; the field required to demagnetise the iron is measured on an ammeter, the demagnetisation being ascertained by a magnetoscope. For soft iron the hysteresis coefficient y in Steinmetz's formula is equal to the coercive force multiplied by 0·00135.

G. H. B.

2179. *Direction of Magnetisation in Beds of Clay Baked by Lava Streams.* **B. Brunhes and P. David.** (Comptes Rendus, 133. pp. 155–157, July 15, 1901.)—The authors have applied Folgheraiter's ideas, [see Abstract No. 1506 (1900)] on the information as to the direction of the magnetic field during the baking of bricks to be obtained for their permanent magnetism, to the beds of clay in the Puy-de-Dôme region which have been baked by lava streams. Small cubes of the baked clay were cut out, the edges being respectively parallel and perpendicular to the present magnetic meridian and vertical, and the directions of their permanent magnetisation determined by a magnetometer method. In the case of cubes taken from the same lava stream the results agree fairly well; cubes taken, however, from different lava streams give widely divergent results, and the authors suggest that the method might be of use in determining whether two lava streams were contemporaneous or not.

W. W.

2180. *Connection between Shape of Pole-pieces and Pull of an Electromagnet.* **W. Beneke.** (Elektrotechn. Zeitschr. 22. pp. 542–544, July 4, 1901.)—The pole-pieces of tractive electromagnets are variously shaped by different makers. The author assumes that the surfaces between which attraction takes place are conical and coaxial, one being convex and the other concave. Assuming that the lines of induction run straight across between the two surfaces in a direction normal to both, and neglecting the effects of fringing, the author calculates the pull for a given total number of ampere-turns and length of air-gap in terms of the semi-vertical angle of the cone. He finds that the strongest pull is obtained when this angle is about 28° for cast-iron, and about 20° for cast-steel. This conclusion is verified by experiment. The author points out that no pole-piece of irregular shape is better than a conical one, for since a definite angle is required for maximum pull, there will be only one portion of the irregularly shaped surface which will have this angle, while all the other portions will have angles corresponding to smaller pulls. There is thus no advantage in using the complicated shapes adopted by some makers.

A. H.

MEDICAL ELECTRICITY.

2181. *Physiological Action of Magnetic Field.* **V. Grandis.** (Accad. Sci. Torino, Atti, 36. 9a. pp. 321–326, 1901.)—Schiff thought that exposure of a nerve to lines of force lengthened the period of latent excitation of the corresponding muscle: the author finds the results do not authorise this conclusion. When a nerve is excited by an induced current, while a portion of its length is in a magnetic field, the period of relaxation of the muscle is considerably prolonged, and the muscle does not completely regain its original length until the magnetic field is withdrawn. When the magnetic field is being formed, if the lines of force are at right angles to the nerve fibres, there is a contraction of the muscle; if they are parallel with these, there is no such effect. In some cases the contraction just referred to may exist at both make and break; in some, at break only. Rhythmically interrupted magnetic fields may give rise to a fatigue-curve, and the muscle-nerve preparation may become completely exhausted to this stimulation, while it will still respond by another fatigue-curve to direct stimulation of the nerve by a rhythmically interrupted current, primary or induced; reciprocally, the magnetic field, if interrupted, can elicit a rhythmical fatigue-curve from a nerve and muscle already exhausted by direct stimulation. The effects of the magnetic field are in any case minute, and any change in the electric condition of the nerve is not measurable. A. D.

REFERENCES.

2182. *Fire-damp Detector.* **G. Léon.** (Comptes Rendus, 132. pp. 1408–1410, June 10, 1901.)—This apparatus is based on the difference between the electric resistances of two platinum wires both traversed by the same current and placed one in pure air and the other in the damp. A. D.

2183. *Electrolytic Condensers.* **A. Trowbridge.** (Phys. Rev. 12. pp. 359–362, June, 1901.)—Electrolytic condensers appear to have been suggested first by C. F. Varley (Phil. Trans., 1872). In the present paper A. Trowbridge shows how an artificial cable can be built up by using electrolytic cells in place of ordinary condensers. A description of Varley's artificial cable is given in "Notices of the Meetings of the Royal Institution," vol. v. 1866–1869. The e.m.f. of the battery should be kept low. A single Daniell or Leclanché cell is generally sufficient for demonstration purposes. R. A.

2184. *Ohm's Law.* **J. Stark.** (Ann. d. Physik, 5. 4. pp. 793–802, July, 1901.)—A theoretical paper on the ionic theory of conduction in metals, liquids, and gases, considered with respect to the tenability of Ohm's Law. W. C. H.

2185. *Analysis of Oscillatory Discharges by Braun Tube.* **F. Richarz** and **W. Ziegler.** (Phys. Zeitschr. 2. p. 432, 1901.)—Chiefly an answer to Simon and Reich to correct an impression that the electrostatic deviation had been observed and not the magnetic. G. E. A.

2186. *Heating of Electric Conductors.* **G. Crivellini.** (Elettricita, Milan, 20. pp. 389–391, June 22, 1901.)—The author works out a formula giving the temperature of equilibrium of a bare wire in air, when heated by the passage of an electric current. He gives two tables of the currents required to heat wires of various sizes to different temperatures, for copper and aluminium. G. H. B.

2187. *Theory of Oscillators for Wireless Telegraphy.* **G. Seibt.** (Elektrotechn. Zeitschr. 22. pp. 580–584, July 18, 1901.)—The theory of the apparatus used by Slaby as an oscillator is considered, especially with regard to the coil or "multiplier." The method of analysis is that employed by Steinmetz in his treatise on Alternating Current Phenomena. In the first part of the paper a comparison is made between a straight-wire conductor and Slaby's coil; in the second part the investigation deals with the problem of calculating the best frequency to use with a coil of given dimensions. R. A.

2188. *Magnetic Measurement by the Ballistic Method.* **J. A. Montpellier** and **M. Aliamet.** (Électricien, 21. pp. 387–389, June 22; 22. pp. 2–7, July 6; 33–36, July 20; and 57–59, July 27, 1901.)—This paper describes the construction of a d'Arsonval galvanometer suitable for ballistic measurements, methods of calibration, and Rowland's, Hopkinson's and Ewing's methods of obtaining the hysteresis curves of iron. The methods of measurement are described in full detail, and are illustrated by numerous diagrams. G. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2189. *Constitution of Cast-Iron.* **H. M. Howe.** (Metallographist, 4. pp. 177–199, July, 1901. Paper read before the American Inst. of Mining Engineers, Richmond, Feb., 1901.)—A slowly cooled or white cast-iron free from graphite consists essentially of soft, copper-like ferrite, and hard glass-like cementite (Fe_3C); its hardness increases and its ductility decreases as the percentage of carbon increases, but the tenacity increases up to about 1 per cent. of carbon, and then decreases as the percentage of carbon is further increased. Grey cast-iron consists essentially of graphite embedded in a metallic matrix, which is similar in all respects to steel or white cast-iron. The properties of the mass should therefore be determined by two factors—(1) the percentage of combined carbon, which determines the character of the matrix, and (2) the percentage of graphite, the soft particles of which, embedded in the matrix, would seriously reduce the ductility, tenacity, and hardness of the mass.

The strongest steel is that which contains 1 per cent. of combined carbon and no graphite, and it is urged that the nearer a cast-iron approaches to this limit the stronger will it be, for the additional carbon if present as graphite would weaken the mass, and if present in the metallic matrix would reduce its tenacity. T. M. L.

2190. *Invisible Liquid Films and the Surface-tension of Liquid Precipitates in the case of Semi-permeable Membranes, Cells, Colloids, and Jellies.* **G. Quincke.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 858–874, July 25, 1901.)—The phenomena exhibited by such precipitates as copper ferrocyanide formed at the junction of copper sulphate and potassium ferrocyanide solutions, by jellies, colloids, and colloidal solutions, are attributed by the author to the action of capillary forces acting at the interface of two *liquid* media, which constitute (with the vapour) the coexistent phases of a two component system. The author regards colloidal solutions as pseudo-solutions, similar to milk, *i.e.*, as consisting essentially of two different phases. He regards the floating particles and the surrounding fluid as aqueous solutions of one and the same colloid, but of different concentration and viscosity. Coagulation is regarded as due to the coalescence of the liquid walls of the floating-particles, whereby a network of foam-cells is produced. When this occurs the colloidal solution becomes a jelly.

[It may be remarked that very similar views with respect to colloidal solutions and jellies have been already expressed by van Bemmelen, W. B. Hardy, and the Abstractor.] F. G. D.

2191. *Thermo-chemistry of very Dilute Solutions.* **H. v. Steinwehr.** (Zeitschr. Phys. Chem. 38. pp. 185–199, Aug. 23, 1901.)—The author first describes the method employed by him to measure very small quantities of heat evolved in such chemical reactions as the dissociation of acids. The measurement is made by means of a thermo-element; the quantity of heat to be measured being either compensated by another quantity which can be accurately determined, the thermo-element in this case being used as a null-instrument, or comparison is made between the galvanometer readings obtained with the unknown and with a known quantity of heat respectively. Two calorimeters of almost exactly equal capacity are made use of, compensation being effected by means of the one, while in the other the heat to be measured is evolved. If the latter is negative in sign, only one calorimeter is employed. An incandescent lamp, the heat from which can be exactly measured, serves as a standard. A short abstract is given of the measurements made, the full details being given in the author's Inaug.-Dissert. (Göttingen, 1900). The following are the results given :—$\partial Q/\partial b$ for sulphuric acid, for concentrations of 23–27 mols. of water to 1 of acid ; the heat of dilution of 4·50–0·10 normal hydrochloric acid ; the heats of neutralisation of barium and sodium chlorides in dilute solution ; the heat of dissociation in cals. of the following acids, the number in brackets giving the temperature at which the measurement is made, whilst $\Delta W/\Delta T$ represents the increase of the heat of dissociation per degree centigrade : Formic acid, − 366 (13·07°) ; acetic acid, − 304 (16–19°) ; dichloroacetic acid, + 1665 (10·9°) and + 1713 (17·2°), $\Delta W/\Delta T = 7·6$; propionic acid, − 243 (15·6°) and − 162 (18·67°), $\Delta W/\Delta T = 26·4$; butyric acid, + 277 (15·47°) and + 387 (19·58°), $\Delta W/\Delta T = 27$; isobutyric acid, + 535 (17·56°) and + 402 (13·1°), $\Delta W/\Delta T = 30$; valeric acid, + 911 (17·58°) and + 805 (13°), $\Delta W/\Delta T = 23$; benzoic acid, − 570 (12·74°) and − 495 (13·5°), $\Delta W/\Delta T = 100$; salicylic acid, − 1317 (13·45°) ; hydrocyanic acid, − 11100 (13–17°) ; phenol, − 5940 (14·6°) and − 6025 (11·5°) ; hydrofluoric acid, + 3006 (19·5°) ; succinic acid (one step), − 565 (16·4°), $\Delta W/\Delta T = 40$; tartaric acid (one step), − 863 (15°), − 1022 (11·2°), $\Delta W/\Delta T = 50$; boric acid (one step), − 3860 (18·2°), − 4040 (16·4°) and − 4140 (13·6°). T. H. P.

2192. *Isobaric Aqueous Solutions.* **J. A. Groshans.** (Zeitschr. Phys. Chem. 38. pp. 163–174, Aug. 23, 1901.)—If one molecule of a chemical compound of "density number" B (Groshans, S. 144. Berlin, R. Friedländer und Sohn, 1895) be dissolved in Aq water molecules, determinations for various isobaric solutions show that they are of the same density ; in two isobaric solutions B and Aq have respectively the same values. From a comparison of the two formulæ—

$$r = \frac{18Aq + A}{d} - 18Aq, \qquad \text{and } d = \frac{3Aq + B\gamma}{3Aq + 3M}$$

the equation $r = A + 18M - 6B\gamma$ is derived, A being the molecular weight of the substance, r the difference between the volume of the solution and the volume of the water, γ and M numerical constants. γ, though sometimes 1, is generally $\sqrt{1·5}$; and, as this is equal to the ratio of Trouton's two constants 21·139 and 25·89, the author considers this an indication of the solution of a substance with the smaller value of the constant in a solvent with the larger value of the constant. M vanishes for bodies of the formulæ $R'(OH)$, $R''(OH)_2$, $R''(ClO_3)_2$, is 1 for the combinations $R'X$, $R''X_2$, X being Cl, Br, I, or NO_3, for $R'''(Cl_3)$, R'_2CrO_4, and IO_6H_5, and − 1 for R'_2CO, and R'_2SO_4 ; while, for the fatty acids and their salts with R', M rises by 1·25 for each additional CH_2, from the value 1 for formic acid. Combinations to be isobaric must have the same values for M and γ, as well as for B. Various tables are given comparing the results of calculation with experimental data. W. E. T.

2193. *Decomposition of Carbon Dioxide by Electric Discharge at Low Pressures.* **J. N. Collie.** (Chem. Soc., Journ. 79. and 80. pp. 1063–1069, Aug., 1901.)—The author sets out to decide whether, and how far, carbon dioxide is decomposed when an electric discharge is passed through it. The gas, at a pressure of a few mm., is exposed to the discharge for varying periods, and then pumped out until several cc. are obtained. With aluminium electrodes it is found that from 65 to 70 per cent. of the gas is decomposed. If platinum electrodes are used a much smaller percentage is broken up, if the kathode is allowed to get very hot, but about the same amount if the current is made feebler. An electrodeless discharge decomposed about 60 per cent. in five minutes. By varying the conditions it is shown that there is continual decomposition and recombination. The rate of change is greatly increased by a reduction of the pressure, 10 secs. sufficing to reach the equilibrium stage at a pressure of 1 mm. R. S. W.

2194. *Relations between Physical Constants and Constitution in Benzenoid Amines.* II. **P. Gordan** and **L. Limpach.** (Chem. Soc., Journ. 79. and 80. pp. 1080–1085, Aug., 1901.)—The author gives the melting-points of two series of compounds, thirty-six in all, obtained by the replacement of the benzenoid hydrogen in formanilide and acetanilide by methyl groups. The melting-points of the acetyl derivatives are, with but one exception, higher than those of the corresponding formyl compounds. Certain numerical relations are obtained between the melting-points in the two series, and the author shows how such relations can be employed to calculate the melting-point of an unknown compound. T. H. P.

2195. *Diffusion of Hydrogen through Palladium.* **A. Winkelmann.** (Ann. d. Physik, 6. 1. pp. 104–115, Aug., 1901. Communicated in abstract to the Medical and Natural Science Society of Jena, May 17, 1901.)—The author gives the results of a number of experiments made to determine the relation between the diffusion of hydrogen through heated palladium and the pressure of the diffusing gas. He finds that the quantity of hydrogen passing through glowing palladium is not proportional to the pressure of the gas, but at low pressures is greater than would correspond with such proportionality. The numbers obtained would be well explained by supposing that dissociation of the hydrogen takes place and that the amount of diffused gas is proportional to the pressure of the dissociated molecules. It is therefore probable that glowing palladium is only traversed by atoms, and not by molecules, of hydrogen. T. H. P.

2196. *Rapid Gas Analysis by the Spectroscope.* **Berthelot.** (Annal. Chim. Phys. 23. pp. 447–482, Aug., 1901.)—A simple apparatus is figured, in which the gas is confined over mercury in a plain eudiometer tube, with a platinum wire terminal fused in the top. The other terminal is fused through one end of a glass U-tube, and the long conducting wire passes within the tube and out of the trough. This arrangement is then pushed up into the eudiometer from beneath, and enables the distance between the terminals to be varied as required. The spectroscope, with two series of prisms, clearly separated the D lines; an induction coil, with rapid interrupter, Leyden jar, and two accumulators, were used, and 5 to 10 cc. of gas were examined each time at the ordinary pressure. Each observation should last only a few seconds, to avoid decomposition of the gas and danger to the apparatus from heating. The characters and wave-lengths of the most prominent rays for a large number of gases and vapours are given, with a useful index to the lines and bands, and the substances producing them. S. R.

2197. *Separation of the Least Volatile Gases of Air, and their Spectra.* **G. D. Liveing** and **J. Dewar.** (Roy. Soc., Proc. 68. pp. 389–398, July 30, 1901.)—A diagram is given of the arrangement by which the most volatile of the gases were obtained from their solution in liquid air by fractional distillation at low pressure (Roy. Soc., Proc. 67. p. 467), and a figure of an improved apparatus now used for fractionating the least volatile portions. These are passed from a gasometer into a bulb, which is cooled till they solidify. The solid is then allowed to evaporate very slowly through an exhausted tube with terminals and the spectrum continually observed. The gas of the lowest boiling-point—in this case nitrogen—is succeeded with comparative abruptness by that of the next boiling-point, and so on, the change being indicated by the spectrum, so that the fractions can be easily stored separately. The alteration of the spectra of Xenon and Krypton by introducing a jar discharge, as noticed by Runge, is very marked, and may possibly indicate another gas. A prism spectroscope was used for the sake of more light. A table of the Xenon and Crypton rays is given; the latter agree fairly with Runge's list but are more numerous; the former differ from Erdmann's observations.

S. R.

2198. *Molecular Constitution of Supersaturated Solutions.* **W. N. Hartley.** (Roy. Dub. Soc., Proc. 9. pp. 529–542, Aug. 8, 1901.)—The view is advanced that supersaturated solutions contain, in solution, a less hydrated salt than that which usually separates from the solution, and that complete hydration does not occur until a crystal of the fully hydrated salt is added. In support of the view that a partially hydrated salt can exist indefinitely in solution, the analogous behaviour of anhydrous salts is quoted; many of these, such as anhydrous gypsum, are insoluble in water. Anhydrous manganous sulphate and anhydrous copper sulphate, when mixed with small quantities of water, set into a hard cake, which slowly becomes hydrated, and then dissolves; but the anhydrous salts do not appear to be soluble as such, and can remain for a considerable period in contact with water before becoming hydrated.

Supersaturated solutions can be prepared by the action of *cold* water on anhydrous salts, and Nicol has therefore suggested that such solutions may contain the anhydrous salt, which becomes hydrated at the moment when crystallisation takes place. This view is somewhat similar to that given above, but the fact that a supersaturated solution of sodium sulphate slowly deposits a small amount of the hydrate with $7H_2O$ affords evidence that this hydrate, rather than the anhydrous salt, is to be regarded as the chief constituent in the solution. T. M. L.

2199. *Heat Evolution on Wetting Powders.* **C. E. Linebarger.** (Phys. Rev. 13. pp. 48–54, July, 1901.)—The author gives results of measurements of the amount of heat evolved when water, benzene, toluene, nitrobenzene, and pyridine are brought into contact with precipitated silica of two different degrees of fineness, the average diameter of the granules being in the one case 0·0005 and in the other 0·00096 cm. The results show that the proportion of liquid taken does not seem to influence the heat effect; a certain minimum quantity of liquid is necessary to produce the maximum heat change, but any excess over that amount has no perceptible influence. In general, the heat effect is greater the finer the powder. In the cases of water, toluene, pyridine, and nitrobenzene the heat effect obtained with the finer silica is about twice that with the coarser, the diameter of the granules in the latter case being about double that of the others. With benzene, however, the same heat effect is produced with either powder. The different liquids examined do not vary much in their heat effects, the largest being obtained with water and the smallest with benzene; pyridine and nitrobenzene, although chemically allied to benzene, exhibit heat effects approaching that of water.

T. H. P.

2200. *Calculation of Heats of Solution by Kirchhoff's Formula.* **F. Jüttner.** (Zeitschr. Phys. Chem. 38. pp. 76–118, Aug. 6, 1901.)—Kirchhoff's law, $\partial Q/\partial x = RT^2(\partial/\partial T)\log(P/P_0)$ is in disagreement with von Babo's $(\partial/\partial T)\log(P/P_0) = 0$, since $\partial Q/\partial x$ certainly differs in general from 0. Here Q is the heat of formation of a solution of 1 molecule of salt in x molecules of solvent at absolute temperature, T, P and P_0 being the saturation pressures at T, of the solution and the pure solvent respectively. The former law is well grounded theoretically, but direct measurements of P and P_0 seem to confirm the latter; these measurements, however, require to be exceedingly exact to give the ratio P/P_0 with the needful exactness, and may herein be deficient. The author has therefore re-examined the validity of these laws by estimating the ratio from the differences between (1) the boiling-points, (2) the freezing-points of concentrated solutions and of the solvent, and has obtained *quantitative* confirmation of Kirchhoff's law with solutions of KCl, KNO_3, and NaCl in water; *qualitative* confirmation he has also obtained with many other substances, for the full examination of which data are lacking.

R. E. B.

2201. *Physical Isomerism of Thallous Picrate.* **W. O. Rabe.** (Zeitschr. Phys. Chem. 38. pp. 175–184, Aug. 23, 1901.)—In the preparation of thallous picrate by mixing aqueous thallous hydroxide with either an aqueous or alcoholic solution of picric acid, slender yellow needles first separate out from the liquid, and when left in contact with the mother liquor these needles gradually change into red crystals. Both these forms have the composition of thallous picrate, $C_6H_2(NO_2)_3OTl$. The yellow needles are, however, triclinic, approximating to monoclinic crystals, and have the density 2·993 at 17°; the red form, on the other hand, is monoclinic hemimorphic, the density at 17° being 3·164. Neither modification is isomorphous with the rhombic potassium picrate, as is seen from the difference in shape and from the inability to form mixed crystals. The transformation of the yellow into the red form proceeds very slowly at temperatures below 50°, but more quickly when in contact with a solvent, and under the influence of light. The opposite change takes place more and more rapidly as the temperature is raised. Solubility determinations of the two forms in water and methyl alcohol show that the exact temperature of transition is 46°.

T. H. P.

2202. *Law of Physico-chemical Processes.* **G. N. Lewis.** (Zeitschr. Phys. Chem. 38. pp. 205–226, Aug. 23, 1901. Also Amer. Acad., Proc., June, 1901, trans. by E. Brauer.)—The author seeks to bring under a more general law the numerous equations and propositions of thermodynamics without loss of their concrete signification or immediate applicability. A reduction is given of the equation of Clausius for change of vapour pressure with change of temperature, by means of Poynting's equation connecting vapour pressure, total pressure, and the molecular volumes of the fluid and its vapour. However, instead of employing this equation, by means of the quantity called the "Fugacity" (previously described as the "passing-over tendency"; see Amer. Acad., Proc. 36,145, 1900, and Zeitschr. Phys. Chem. 35, 343, 1900), he proceeds to deduce other exact equations of the same form. The effect of temperature and pressure on the fugacity is determined, and a simple equation given, comprising every change of state of a simple substance. This equation is confirmed by discussing the influence of pressure, temperature, surface tension, and electrical potential on the fugacity. Finally, a method is developed for determining fugacity by means of vapour pressure. W. E. T.

2203. *Validity of the Ionisation Theory.* **L. Kahlenberg.** (Journ. Phys. Chem. 5. pp. 339–392, June, 1901.)—After alluding to the work of Dutoit and Friderich, Walden, Franklin and Kraus, and Costoro upon certain non-aqueous electrolytic solutions whose behaviour appears abnormal, according to the ionisation theory, the author describes experiments on aqueous solutions carried out in conjunction with A. A. Koch and R. D. Hall. The solutions varied from concentrated to dilute, one gramme equivalent of solute being contained in from ½ to, say, 5,000 litres. The molecular weights were determined both by freezing-points and by boiling-points, and conductivity measurements were made both at the freezing-point and near the boiling-point. The conductivity was determined of the following salts :—NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $HgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$, and $CuSO_4$. Freezing-points were determined for NaCl, $MgSO_4$, $ZnSO_4$, $CdSO_4$ $NiSO_4$, $CoSO_4$, $FeSO_4$, and $CuSO_4$, and boiling-points for NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $AgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$, and $CuSO_4$. The results are given in full in the original paper. The main object of the author was to see to what extent the degrees of ionisation found by these four methods agree among themselves.

The agreement between conductivity at 0° and the freezing-point method is poor, even in dilute solutions. The conductivity, as a rule, seems to indicate much higher ionisation than does the freezing-point. Arrhenius originally accounted for such discrepancies by assuming polymerisation, basing this upon variation of migration numbers with concentration, as found by Hittorf, but this assumption was not consistently applied.

The boiling-point method shows irregularities which do not appear in conductivity measurements. *E g.*, in the case of NaCl, KCl, KBr, and KI, the molecular weights continually diminish with increase of concentration, finally becoming less than half the theoretical value, whereas the molecular conductivity increases with dilution. Similarly the molecular weights of $MgCl_2$ and $BaCl_2$ decrease with increasing concentration until they become less than one-third the theoretical. On the other hand, there is a fair agreement between the two methods in the case of $KClO_3$, KNO_3, and $AgNO_3$. But in the case of $MgSO_4$, $ZnSO_4$, $NiSO_4$, and $CuSO_4$, the molecular weights begin, in the dilute solution, with values above the theoretical, indicating no ionisation; they then increase with the concentration and finally decrease, after passing through a maximum, the values in the concentrated solutions becoming less than the theoretical. Yet there is no irregularity in the conductivity values. The molecular weights of the sulphates are less by the freezing-point than by the boiling-point method, so that if polymerisation is assumed this is greater at the higher temperature. A series of boiling-point determinations were also made on a solution of cane sugar, as an example of a non-electrolyte, and it was found that the molecular weight diminished appreciably as the concentration increased (212 as compared with the normal 342).

From the results obtained it follows that there are solutions which are excellent conductors and which nevertheless show normal molecular weight of the solute. While in some cases the molecular weight increases with the concentration, thus agreeing qualitatively at least with the ionisation theory, in other cases the molecular weight decreases with increase of concentration, finally becoming less than what it ought to be, even for complete ionisation. In other cases the molecular weight at first increases with concentration and then diminishes. But the conductivity of these solutions continually increases with dilution. There are cases, however, in which the conductivity at first increases with the dilution and then decreases, *e.g.*, aqueous solutions of the alkaline hydroxides.

It follows, therefore, that there is no such connection between freezing-points and boiling-points of solutions on the one hand, and their conductivity on the other, as is claimed by the ionisation theory. Often there is not even a qualitative agreement.

It is generally considered that the ionisation theory is supported by various additive properties of electrolytes, but additive properties exist also in cases where ionisation cannot be applied. Again, heats of neutralisation are not sufficiently explained, and the ionisation theory cannot be brought into harmony with the law of mass action. Chemical reactiveness of electrolytes has been explained by ions, but, while this behaviour may be so explained, it does not necessitate the theory, for many pure bodies in which there is no ground for assuming ions are exceedingly active.

The supposed relation of ionising power to specific inductive capacity has been shown not to hold. The dependence of this same property upon the polymerisation of the solvent has been shown to be incorrect by the work of Kahlenberg and Lincoln. The theory of ionisation is supposed to be required by the second law of thermodynamics, but Clausius did not find it necessary to frame such a radical hypothesis as that of Arrhenius. Ionisation has led to Nernst's formula for the e.m.f. of voltaic cells, but this formula really involves the law of mass action, which has been shown not to hold for electrolytes.

If the ionisation theory is not true, there arises once more the original difficulty of interpreting van't Hoff's factor i in the gas equation. Of course this equation is supposed to hold strictly only for dilute solutions. One does not expect it to hold strictly with increasing concentration, but one has a right to expect that a solution should behave at least qualitatively as a gas does with increasing pressure. Apparently the factor i should never be placed equal to unity without experimental evidence, whether in connection with electrolytes or non-electrolytes.

In this theory it has been forgotten that an analogy is all that is being dealt with, and it has been pressed too far. The solution of a substance and the expansion of a gas are really very different. A gas will expand in vacuo, or into any other gas, but a substance will not dissolve in any liquid. Solution depends upon the solvent, but in the theory of solution the important *rôle* of the solvent has so far been neglected. W. R. C.

2204. *Absorption of Ionised Phosphorus Emanation in Tubes. II.* **C. Barus.** (Phil. Mag. 2. pp. 40–49, July, 1901.)—This paper deals with a continuation of the author's former experiments [see Abstract No. 1669 (1901)]. He now proceeds to discuss the absorption by surfaces, or by suspended particles, of atmospheric nuclei, producing condensation. Before passing into the colour-tube, the ionised air is made to pass through absorption-tubes of narrow bore, and it is found that whether these tubes be of glass, of impure grey rubber, of pure brown rubber, or of lead, the absorption velocity (in the absence of an electric field) is practically the same, and is independent of the radius of the tube. With a wide tin tube, this velocity (k) is much smaller, showing the preservative tendency of dilution, but is still independent of the radius. The author proceeds to discuss these experiments mathematically, and computes curves which closely approximate to those given by observational data. He therefore concludes that his hypothesis that the loss of nuclei within the medium itself may be neglected, while the absorption effect of velocity k by the tubes is real, is one of great probability. In the case of the wide tubes where absorption velocity is small, the author adopts the recent suggestions of J. J. Thomson, Townsend, Rutherford, &c., that new ions are produced by collisions. Where the ionised air is markedly diluted, the new ions produced are in excess of the old, and the velocity would then diminish. W. C. H.

2205. *Distance between Dissociated Ions.* **R. Pauli.** (Elektrochem. Zeitschr. 8. pp. 73–74, July, 1901.)—Starting from the assumption that the energy possessed by an electrolyte in solution, in virtue of the positive and negative electric charges of its ions, is supplied by the so-called heat of solution or of dilution, the author proceeds to calculate the distance by which the dissociated ions are separated when no current is flowing through the solution. If r_1 and r_2 are the distances apart of the ions in the un-ionised and ionised molecules respectively, A the mechanical equivalent of heat and L the heat of dilution, then $1/r_1 - 1/r_2 = 981\ \mathrm{LA}/9654^2$. The maximum value of L is about 500 cals., so that the difference between $1/r_1$ and $1/r_2$ becomes approximately $424 \times 981 \times 500/9654^2$ in c.g.s. units. Many compounds, such as hydrogen chloride and sulphuric acid, evolve heat on solution and also on dilution, so that in these cases the ions are farther apart before ionisation than after, whilst when the heat of dilution is zero the distance between the ions remains unchanged. T. H. P.

2206. *Electrocapillary Effect of Non-ionised Molecules.* **Gouy.** (Comptes Rendus, 133. pp. 284–287, July 29, 1901.)—The author employs a Lippmann electrometer with vertical capillary. Both mercury surfaces are in contact with normal Na_2SO_4 solution; the large mercury surface is kept constantly in contact with normal Na_2SO_4 solution, saturated with Hg_2SO_4. Different organic substances are added to the liquid in contact with the mercury surface in the capillary. The height of the mercury in the capillary is plotted as ordinate against p.d. as abscissa. The effect of the organic substances is to *diminish* the height (surface tension). This effect is much more marked in the neighbourhood of the surface-tension maxima, so that the organic substances lower and flatten the curve. Curves are given for phenol and isobutyl alcohol. F. G. D.

2207. *Velocity of Reaction before Complete Equilibrium and before the Point of Transition. Part I.* **M. Wilderman.** (Phil. Mag. 2. pp. 50–92, July, 1901.)—The paper opens with a thermodynamical discussion, as a result of which the author (employing Gibbs's nomenclature) arrives at the following "very remarkable and most general results":—

1. "If one and the same component is affected by two or more potentials at the same time, the condition of equilibrium is that the sum of all the potentials of the same component should be the same through the whole mass, while each of the potentials separately may change in a different direction or directions."

2. "If one and the same component is affected by two or more potentials,

unless they can by themselves be separately constant through the whole system (μ, ν), the values of each of the potentials, including (μ, ν), is not a constant quantity, but a changeable one conditioned in its value by the presence and value of the other potentials."

The main part of the paper gives an account of the continuation of the author's work on freezing-points, &c., employing more elaborate and exact apparatus. F. G. D.

2208. *Hydrogen-Chlorine Gas Cell.* **E. Müller.** (Zeitschr. Elektrochem. 7. pp. 750–752, July 4, 1901.)—A criticism of Akunoff's paper [see Abstract No. 670 (1901)]. The value of q for this cell is 36778 cal. (not 37167); the heat of formation of 3N HCl from its elements is 37854 (not 37680), and by the reduction of hypochlorous acid is 37404 cal.; it is therefore impossible from these data to determine what is the primary action that takes place in the cell, and the author suggests that, as chlorine and hypochlorous acid are both present in equilibrium in the cell, both may be regarded as undergoing direct reduction. T. M. L.

2209. *A Self-Depolarising Cell.* **G. Rosset.** (Soc. Franc. Phys., Bull. 166. pp. 1–2, 1901.) — The depolariser of this cell, ammonium cuprate, becomes reduced to cuprite, which is reoxidised spontaneously by the air at the surface of the cell while the action of the latter still goes on. The exciting liquid has ammonium chloride as its basis, and hence, at the positive pole, evolution of ammonia takes place, which goes to compensate the inevitable loss of ammonia by the depolariser. The latter is prevented from diffusing by the use of a semi-permeable colloidal membrane of copper ferrocyanide, precipitated in the wall of the porous cell; owing to the free ammonia of the depolariser, in which copper ferrocyanide is soluble, this membrane is kept in a colloidal condition, and so remains semi-permeable. When tested according to the official methods of the "Laboratoire Central d'Électricité," that is, when discharged continuously through 10 ohms, the variation in the current was less than 1 milliampere per 24 hours during the month which the trial lasted. The zinc is used up very regularly, the stick wearing away to a fine wire. When the zinc and the exciting solution are renewed, the discharge of the cell follows a curve which is similar to the original one, but 1 milliampere below it. The depolariser is, of course, inexhaustible. T. H. P.

2210. *Polarisation-Capacity of Platinum.* **P. Schönherr.** (Ann. d. Physik, 6. 1. pp. 116–124, Aug., 1901.)—The author gives the results of the study of the polarisation-capacity of cells containing 1/10-normal sulphuric acid, as free from gas as possible, the electrodes being pieces of platinum-foil, of 6 sq. cm. area, kept at a distance of 0·6 cm. apart by means of glass beads. After the cell is charged the capacity is found to fall regularly, at first quickly and afterwards slowly, from 77·1 to 43·6 microfarads after 72 hours; at the same time the apparent resistance increases. When the cell is heated the capacity is found to rise from 41·1 microfarads at 20° to 44·5 at 60°, and then to fall to 40·5 at 79°, whilst after cooling the value is 25·6 microfarads at 17·2°; repetition of this treatment gives further lowering of the capacity to 22·2. An apparent resistance of 7·16 ohms at 20° before heating is changed, after heating, to 8·69 ohms at 17·2°. These results are explained by the diminution of the gas content at the surface, between the platinum and the electrolyte, brought about by the heating. By passing hydrogen over the surface of the electrolyte in the cell, and turning the latter so that the platinum plates come into contact with the gas, the capacity is increased from 20 to 33·4, whilst treatment with oxygen in the same way has no effect. When, by means of an auxiliary electrode placed in a beaker of the electrolyte surrounding the cell, so that the liquids inside and outside the cell are in communication, electrolytic hydrogen or oxygen is evolved at the surface of the electrodes, the capacity rises to 73·8 microfarads—a number almost equal to its initial value. The capacity of the cell with bright platinum electrodes is practically independent of the frequency of the alternating current, but when the electrodes are acted on by a constant polarising force it is found that for different frequencies the capacity is approximately proportional to $1/\sqrt{m}$, where $m/2\pi$ is the frequency. About 20 hours after the removal of the polarising force the cell returns to its original condition, in which the capacity is almost independent of the frequency. The removal of gas from the surface of the platinum can be effected by igniting the plates, and in this way results are obtained similar to those produced by heating the whole cell. T. H. P.

2211. *Dissociation-Equilibrium of Highly Dissociated Electrolytes. II.* **H. Jahn.** (Zeitschr. Phys. Chem. 37. pp. 490–508, June 18, 1901.)—In this paper a novel attempt is made to explain why the dissociation-equation in its ordinary form does not hold for highly dissociated electrolytes. In obtaining the dissociation-equation in its usual form, one of the premises is that the energy can be expressed as a linear function of the concentrations. According to Jahn this assumption is only legitimate when the forces acting between the molecules are the ordinary intermolecular attractive forces, which become vanishingly small at extremely small distances; it is not legitimate, however, for the case of the electrostatic force acting between charged ions. Hence Jahn introduces into the energy-equation terms involving the squares and products of the ionic concentrations. [See further Abstract No. 183 (1901).] This leads to the dissociation-equation :—

$$C^2/(c-C)\,.\,\lambda^{-C}=k$$

for the case of a binary electrolyte, where $C =$ concentration of anion or kation, $c =$ total concentration, λ and $k =$ constants. This equation is then tested by means of the freezing-point results of Hausrath, Abegg and Loomis, obtained with solutions of NaCl, KCl, NH_4Cl, KNO_3, $NaNO_3$, NH_4NO_3. The results appear to indicate a pretty fair agreement, assuming the above equation to be the true one. Jahn then shows that the expression for the e.m.f. of a concentration-cell takes the form :—

$$dE=\frac{mRT}{\epsilon}\left(\frac{2dC}{C}-\frac{c-C}{c}\log\lambda\,dC\right)$$

According to this, Nernst's formula will always give results somewhat in excess of the truth; although the difference will not be great for very dilute solutions, and is not sufficient to explain the divergences previously observed by Jahn. The latter he now ascribes to possible experimental errors, and all his previous conclusions founded thereon are withdrawn.

In the Zeitschr. Phys. Chem. (38. pp. 125–126, Aug. 6, 1901), the author makes a correction. It is pointed out that the experimental results cited in the above paper in support of his theory are not really applicable, because deviations from the simple gas laws cannot be supported by results which

themselves involve the laws. The theory proposed by the author remains, therefore, as it was, but the experimental verification is yet to be obtained.
F. G. D.

2212. *Osmotic Pressure Observation.* **M. Oker-Blom.** (Zeitschr. Phys. Chem. 37. pp. 744–750, July 12, 1901.)—A copper ferrocyanide membrane is permeable to sodium chloride, although impermeable to copper sulphate. The author finds that when dilute copper sulphate is placed on one side of such a membrane, and a concentrated sodium chloride solution on the other, the pressure on the copper sulphate side first falls, owing to water passing from it through the membrane. Sodium chloride, however, gradually permeates the membrane until the pressure due to it is the same on both sides, so that an excess of pressure is produced on the copper sulphate side.
T. H. P.

2213. *Theory of Drop Electrodes.* **J. Bernstein.** (Zeitschr. Phys. Chem. 38. pp. 200–204, Aug. 23, 1901.)—By means of a quick-acting capillary electrometer, the author observes and photographs the change of the potential difference between a drop-electrode and a layer of mercury in dilute sulphuric acid. He finds that the potential difference remains constant during the formation of the drop, but that, as soon as the latter falls, an extraordinarily quick current swing proceeds in the direction from the dropping mercury through the electrolyte to the mercury at rest. By comparison with the time-curve of the electrometer, when an e.m.f. of 1/101 of a Daniell element is included in its circuit, it can be shown that the potential difference between the surface of mercury and dilute sulphuric acid rises to 0·84 of its final value in 0·015 second. A short opposite movement of the mercury meniscus, which takes place at the beginning of the current swing, is supposed by the author to be due to the return into the capillary of the thread from which the drop is torn.
T. H. P.

2214. *Triple-points.* **G. Tammann.** (Ann. d. Physik, 6. 1. pp. 65–73, Aug., 1901.)—If a substance is polymorphic as a solid, it has several ice, hoar-frost, and transformation lines, corresponding to the possible states of equilibrium of liquid-solid, vapour-solid, solid-solid; as well as the steam line for the vapour-liquid equilibrium. Wherever any three of these intersect is a triple-point, and the general theory of all such triple-points is here given, together with the relation between the slopes of these lines to the axes on a pt-diagram, and the slopes to the axes on a ϕv-diagram of the sides of the triangle which represents the corresponding triple-point.

A description is also given of the character of triple-point diagrams for CO_2 and trimethyl carbinol (dimorphic), water and AgI (trimorphic), methyl iodide (tetramorphic), sulphur and acetic acid.
R. E. B.

2215. *tp-Diagrams for Methyl-iodide and Acetic Acid.* **R. Hollmann** and **G. Tammann.** (Ann. d. Physik, 6. 1. pp. 74–83, Aug., 1901.)—The ice and transformation lines for methyl-iodide were investigated within the range —20° C. to 60° C. of temperature, and 1 to 3,200 kilos per sq. cm. of pressure; the resulting diagram shows the substance to be tetramorphous within this range, and to exhibit six triple-points: (1) at 5·71° and exceedingly low pressure for vapour, liquid and A-solid; (2) at —6·5° and still lower pressure for vapour A-solid and D-solid; (3) at 9·1° and 210 kg./cm^2. for liquid, A-solid and B-solid; (4) at 10° and 360 kg./cm^2. for A-solid, B-solid and D-solid; (5) at 48·1°

and 1790 kg./cm^2. for liquid, B-solid and C-solid; (6) at 85·5° and 2020 kg./cm^2. for B-solid, C-solid and D-solid. From this we see that the D-solid cannot melt until after the transformation into one of the other solid forms, but it can vaporise directly.

Former observations on acetic acid are corrected and extended; this substance showing itself dimorphous within the range 0°–70° C. and 1–3000 kg./cm^2., with two triple-points: (1) at 16·65°, and very low pressure, for vapour, liquid and A-solid; (2) at 57·5°, and 2880 kg./cm^2. for liquid, A-solid and B-solid.

[The authors distinguish the crystal forms by numbers, not letters as above.] R. E. B.

2216. *Accumulators of other Metals than Lead.* **S. v. Laszczynski.** (Zeitschr. Elektrochem. 7. pp. 821–827, Aug. 8, 1901.)—The use of nickel oxide, Ni_2O_3, as depolariser for the positive plate of an accumulator, has several advantages in the case of a properly constructed plate. Whereas the reduction of cuprous oxide reduces the e.m.f. produced at the negative plate by 0·95 volts, the e.m.f is increased by 0·04 volt where nickel oxide is used, as the compound is slightly endothermic and gives out energy during the reduction. The plates can be made much lighter than in the case of lead, as the metallic nickel gauze that is used as a basis for the plate is quite unattacked, and can be made of very thin wire. The negative plate is made of zinc immersed in an alkaline electrolyte; the nickel, unlike copper, is quite insoluble in the alkali, and there is no tendency for it to be deposited on the zinc. The combination has an e.m.f. of 1·84 volts, and the cell is not damaged by overcharging, by complete discharge, or by leaving uncharged. The cost of the nickel is not prohibitive, and for stationary batteries the cell is quite practicable, but for traction work the limited solubility (15 per cent.) of the zinc in the alkali requires the use of too large a bulk of electrolyte.

For traction work a combination in which the electrolyte is not chemically changed has some advantages, for it is only necessary to have enough liquid in the cell to form a conductor between the plates. Such a cell is formed by a combination of porous copper with silver oxide (Ag_2O_2), but it has an e.m.f. of only 0·95 volt. By using cadmium in the place of copper, the e.m.f. is raised to 1·5 volts. The usefulness of this type of cell is limited by the fact that the plates must be put far enough apart to prevent short-circuiting and to allow of the escape of gas-bubbles, and the quantity of liquid cannot be reduced very greatly. T. M. L.

2217. *Electromotive Activity of the Elementary Gases. Part II.* **E. Bose.** (Zeitschr. Phys. Chem. 38. pp. 1–27, Aug. 6, 1901.) *Part III.* **E. Bose** and **H. Kochan.** (l. c. 38. pp. 28–55.)—(Part II.) In Part I. of this paper [see Abstract No. 177 (1901)] the e.m.f. of a Grove gas-battery was found to rise with the time, a result confirmed by Wilsmore [see Abstract No. 906 (1901)]; the maximum now *observed*, when the gases are under atmospheric pressure and at 25° C., is 1·1242 volts, but experiments with electrodes supersaturated by long-continued polarisation *indicate* a maximum of 1·1542 volts. Assuming the mean of these numbers, 1·1392 volts, we have 52654 calories as the free energy of formation of water. Other conclusions are that—(1) the gaseous polarisation of electrodes of noble metals is little more than a surface phenomenon; (2) at the oxygen electrode O, H_2O and H_2O_2 finally come into equilibrium together, but, at ordinary temperatures, and with small currents, only after perhaps months; (3) the H_2O_2 so formed is different in character from ordinary H_2O_2, the former raising the potential and the latter lowering it; (4) heating lowers the potential far below that due to pure oxygen, doubtless by conversion of the one form of H_2O_2 into the other; (5) the theory of the gas-battery is not modified by the part taken by H_2O_2, provided that the state of equilibrium is presupposed.

(Part III.) When electrodes of pure gold in dilute H_2SO_4 are kept for a long time at a high p.d., their surface becomes modified, assuming first a spongy, and then a powdery character. In this state the anode (that in O_2) is singularly sensitive to the action of light. Daylight, electric arc light, magnesium light, &c.; also the violet light of the spectrum, cause diminution of the oxidation-potential; red light, obtained from the spectrum, or with lithium, or by coloured shields, raises this potential, while yellow and green lights have no sensible effect. The observed variations of e.m.f. amounted to as much as 0·1 volt. R. E. B.

2218. *Equilibrium in Gas-Electrodes.* **E. Bose.** (Zeitschr. Elektrochem. 7. pp. 817–821, Aug. 8, 1901.)—In the case of hydrogen-platinum electrodes a state of equilibrium is readily reached in which the platinum is saturated with hydrogen. Neither is any special difficulty experienced in saturating a platinum electrode immersed in hydrochloric acid with chlorine: the only by-product in this case is hypochlorous acid, and, as this is only present in very small quantities, equilibrium is reached as soon as the solution is saturated with chlorine. In the case of an oxygen electrode immersed in sulphuric acid and alkalies, however, a number of by-products, such as hydrogen peroxide and the persulphuric acids, are produced, and the electrode does not show a constant p.d. until these have been produced in the quantity required for equilibrium. When equilibrium is reached an oxygen electrode immersed in sulphuric acid will have the same e.m.f. as an electrode charged with hydrogen peroxide or persulphuric acid; but, until this state is reached, each form will have its own e.m.f. T. M. L.

2219. *Electrolytic Reduction of Nitrites.* **B. Suler.** (Zeitschr. Elektrochem. 7. pp. 831–842, Aug. 15, and 847–855, Aug. 22, 1901.)—Experiments were made on the electrolysis of potassium nitrite solution, between a platinum anode and a zinc kathode. The reduction is markedly influenced by the concentration, current density, and temperature. The highest yield of hydroxylamine is obtained by working with a 5 per cent. solution, at 0°, and a current density of $D_{100} = 2$ amperes, whilst the maximum amount of ammonia is obtained from 15–25 per cent. solutions, with the same current density. The formation of hyponitrous acid was not observed. It appears that the nitrite undergoes reduction directly to hydroxylamine and ammonia. Full details are given in the paper of the electrolyses and chemical analyses involved; there is also an historical introduction. N. L.

2220. *Electrolytic Manufacture of Grinding and Polishing Tools.* **J. Rieder.** (Zeitschr. Elektrochem. 7. pp. 765–767, July 11, 1901.)—This paper deals with the manufacture of carborundum polishing tools, and draws attention to the advantages of this substance over natural emery. The body of the tools is of metal, on which the emery or carborundum powder is fastened by depositing metal electrolytically, generally copper. The emery sand is next moistened with a solution of wax in benzene and dried, each particle thus receiving a fine coating of the dissolved material, and when mixed with graphite takes up the latter, and is rendered conductive thereby. The so-prepared powder is spread over the article to be covered, which is placed as kathode in the plating solution. The copper deposit then fastens the particles on, and by rubbing off the upper surface of the copper the emery is laid bare, ready for use.

Comparisons show that for the same loss of weight with an electrolytic wheel 70 grammes of steel could be ground off, as against 20 grammes with an ordinary one. The chief advantage, in the opinion of the author, is the possibility of making wheels and tools of any degree of smallness and shape, which would be very difficult by the older methods. O. J. S.

2221. *Improvements in the Metallurgy of Aluminium.* **C. P. Townsend.** (Elect. World and Engineer, 38. pp. 14–15, July 6, 1901.)—The preliminary steps in the Hall process for the manufacture of aluminium, *i.e.*, the preparation of pure alumina, forms the first part of this paper. The author cites Roberts-Austen, according to whom 45 per cent. of the total expenses in the manufacture of aluminium are incurred in the purification of the alumina from bauxite.

It has been proposed to dissolve crude bauxite in a fluoride bath and by means of fractional electrolysis eliminate silicon, iron, and titanium, but without decomposing notable quantities of alumina. This method is not satisfactory, owing to the fact that the various voltages for decomposing these compounds lie so close together that they are thrown down simultaneously. C. Hall's recent patents, Niagara Falls (June 25), certainly deserve more consideration, as they promise to reduce the cost of manufacture of aluminium. The new body prepared differs considerably from pure alumina as hitherto obtained, and consists of a greyish-white crystalline body of vitreous lustre, S.G. 3·7 to 3·9, and therefore somewhere near the mineral corundum. According to Hall it contains a certain percentage of a carbide and also of a suboxide (Al_3O_4). Two processes are then described. Bauxite of the following composition was employed: Al_2O_3 60 per cent., Fe_2O_3 18 per cent., SiO_2 2–3 per cent., TiO_2 3–4 per cent., H_2O 17 per cent.

This bauxite is first calcined, mixed with 8–10 per cent. of carbon, and held in fusion in a carbon-lined electrical furnace, heated either by direct or alternating current. No aluminium is thus separated, as already shown by Moissan (Comptes Rendus, 119. p. 935.) The contained impurities are, however, reduced, and, especially in the presence of plenty of iron, settle at the bottom of the bath as a fused ferro-alloy.

The second method is similar to the first, the difference consisting in the employment of metallic aluminium in the molten bath in lieu of the current, for eliminating the undesirable metals. Instead of using pure aluminium, a ferro-aluminium containing about 50 per cent. of each component may be employed with advantage. The only element which has given some trouble is titanium, but, on the other hand, a small percentage of this body is rather advantageous than otherwise if the aluminium is to be employed for structural purposes. O. J. S.

2222. *Sulphide Ore Treatment.* **E. A. Ashcroft.** (Electrician, 47. pp. 451–453, July 12, 1901. Abstract of a paper read before the Institute of Mining and Metallurgy, June 19.)—This paper deals with the experimental work carried out by the author in conjunction with J. Swinburne, which consists essentially as follows:—

(1) Displacement of sulphur (or other elements) from combination with metals in an ore by means of chlorine gas in the dry way.

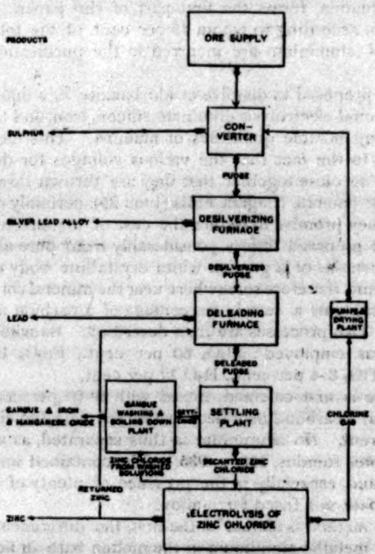
(2) Substitution of one metal for another in a mixture of fused chlorides by precipitation with a metal (or alternately the fractional electrolysis of the mixed chlorides in a fused state).

(3) Separation of siliceous gangue (which is unacted upon) from the final metallic chloride, by settling and decantation, and washing the residues in water (or alternatively by distillation of the chloride from the residues). Purifying the final chloride, boiling down the wash solutions, if any, and preparing the chloride for electrolysis.

(4) Electrolytic decomposition of the final chloride for the recovery of its metal and chlorine.

(5) Pumping the chlorine gas to a suitable pressure.

The displacement of sulphur by chlorine gas is claimed as an original discovery, as regards metallurgy, and the inventors believe that it may have an important future, outside the limits of the particular application in their own process. The method adopted for carrying out this treatment with chlorine involves the employment of a converter, into which are introduced, at a suitable heat, the sulphides under treatment together with fused zinc chloride. The chlorine gas is then injected at the bottom and ore fed in at the top, whilst the resulting sulphur is carried away into a condensing chamber or flue, and there collected. The addition of ore to the converter and the blowing in of gas is continued until the apparatus is full of fused chlorides in liquid form, in which is suspended the siliceous gangue, which is quite unacted upon at the temperature of working. The greater part of the contents of the converter is then run off for further treatment, the remainder retaining sufficient heat to enable the process to be resumed by blowing in more gas and putting in more ore.



In a trial run lasting twelve hours, with 1,000 kg. mixed sulphide ore of the following composition—

Pb	29 per cent.	Gangue (by difference)	17 per cent.
Zn	26 „	Fe	5 „
S	21 „	Mn	2 „
	Ag, 19 oz. per ton.		100

470 kg. chlorine gas were used, 100 kg. sulphur were recovered, and 1,260 kg. fused chlorides were obtained, containing 23 per cent. lead, 21 per cent. zinc and 13·5 per cent. suspended gangue, in addition to iron, manganese, and chlorine. The silver in this chloride mixture amounted to 15½ oz. per ton.

The silver (and gold if present) is extracted by agitating the fused mixture with metallic lead. A rich bullion can be obtained in this way, containing the whole of the precious metals. Lead is removed by substitution of zinc, which is converted into zinc chloride and recovered in the fourth step of the complete cycle of operations. Before electrolysing the zinc chloride, it is necessary to remove all the interfering iron, which is done by the application of a blast of air at a certain stage of the converter process, the suspended Fe_2O_3 being afterwards removed from the gangue.

The removal of the gangue and oxides of iron and manganese is the thir operation. This is effected by allowing the fused zinc chloride to stand, decanting from time to time the cleared portion of the chloride, the residues being treated in one of several ways. The method usually adopted is to wash, concentrate, and remove traces of water, iron, lead, and other impurities by means of a short preliminary electrolysis with a cheap form of carbon anode, which is destroyed by the oxygen liberated, then adding the concentrated pure solution to the main bulk of zinc chloride. The advantage of this preliminary treatment is that a completely neutral zinc chloride, free from hydrogen, iron, or lead, is obtained, which does not destroy the carbon anodes of the main vat system.

The fourth and final step is the electrolysis of the fused zinc chloride, and recovery of the zinc and chlorine. This is conducted in a large steel tank, lined with 18 inches of firebricks, the inner layers of which are set in a special cement, the kathode being a mass of molten zinc and the anode consisting of a removable cast-iron plate, lined on the under side with special cement, from which depend 120 2½-inch rods of hard carbon immersed about 6 inches in the electrolyte.

Sketch No. 2 is a diagrammatic representation of the various steps in the Phœnix process, showing that the process is truly cyclic in character.

Allowing for freight charges upon the raw ore and upon concentrates, the costs and profits, compared with the concentration process now being used for Broken Hill ores, works out as follows :—

	Net recoveries.			Total Costs.			Profit.		
	£	s.	d.	£	s.	d.	£	s.	d.
Concentration at Broken Hill and smelting in Europe or Port Pirie	2	15	0	1	15	0	1	0	0
Phœnix worked in Europe	8	10	0	5	5	6	3	4	6
Phœnix worked at Port Pirie	8	10	0	4	16	6	3	13	6

(Including costs of marketing products.)

An appendix and twelve plates are given with the complete paper.

J. L. F. V.

2223. *Nickel Plating and Polishing in Revolving Drums.* (Électricien, 22. pp. 101–104, Aug. 17, 1901.)—This is a description of the Delval and Pascales system of plating small articles with gold, silver, nickel, or copper in revolving drums. The special feature of the process is the commutator which supplies the current to the anode connections inside. Usually these are permanently connected to the source of current, no matter whether doing work or not. As the drum is never more than half filled with articles to be plated, only the lower bars are electrically connected with them, while the upper ones are wasting any current that may pass through them, and are receiving a coating of the metal themselves, so that they increase in size very quickly. By means of this commutator the bars not actually touching the articles in the drum are cut out of circuit, and thereby any leakage of current through them is prevented. The paper is illustrated with diagrams and views of the apparatus.
J. L. F. V.

2224. *Ozone for Sterilisation of Water.* **F. Krall.** (Elektrochem. Zeitschr. 8. pp. 99–102, Aug. 1, 1901.)—This paper contains an illustrated description of the Marmier and Abraham apparatus for water purification as exhibited by the "Soc. Industrielle de l'Ozone" at the Paris (1900) Exhibition. A detailed description of the ozoniser is followed by details of the installation at Lille, and of the results obtained there [see Abstracts Nos. 1755 and 1756 (1899)]. As regards efficiency and cost, 1 h.p.-hour is said to yield 20 grammes of ozone, and to ozonise 3·4 cubic metres of air. The actual cost of water sterilisation depends, however, largely upon the local circumstances, and no general estimate of cost is reliable. The author considers that, even when dealing with badly contaminated river water, the cost of sterilisation by ozone, added to that of the preliminary filtration through sand, would not exceed that of water drawn from distant sources.
J. B. C. K.

REFERENCES.

2225. *Electrolysis of Fused Salts.* **R. Lorenz.** (Zeitschr. Elektrochem. 7. pp. 753–761, July 4, 1901.)—A paper on the same lines as that noticed in Abstract No. 425 (1901).
N. L.

2226. *Incandescent Electric Furnaces.* **J. Joly.** (Roy. Dublin Soc., Proc. 9. pp. 482–484, July 6, 1901.)—A short description of small laboratory furnaces.
W. R. C.

2227. *Chemistry of Extreme Temperatures.* **G. Bredig.** (Phys. Zeitschr. 2. pp. 418–422, and 433–438, 1901.)—This paper is a review of the recent progress made in attaining and measuring very high and very low temperatures, and gives the latest determinations of the boiling- and melting-points of many substances. It treats also of dissociation and the solubility of gases in metals at high temperatures, electric and electrolytic conductivity, and various phenomena in thermo-chemistry.
G. H. B.

2228. *Generalisation of Clapeyron's Equation.* **P. Saurel.** (Journ. Phys. Chem. 5. pp. 393–400, June, 1901.)—Clapeyron's equation, $dp/dt = (\partial\eta/\partial v)_t$, originally given for a univariant system, is here extended to the indifferent points of a multivariant system. [See Abstract No. 937 (1901).]
R. E. B.

2229. *Thermodynamics of Electrical Deposition.* **M. Frank.** (Elektrochem. Zeitschr. 8. pp. 86–91, July, 1901.)—A discussion of the thermal conditions in which electrolysis takes place.
J. E.-M.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

2230. *The Science of Steam-raising.* **J. C. Parker.** (Eng. Club Phil., Proc. 18. pp. 147–155, July, 1901.)—Some of the physical conditions of steam generation are graphically represented by a diagram in which the vertical scale gives temperatures from 0° F. upwards, 2,500° F. being taken as the initial temperature of combustion. A curve is drawn from that point to represent a gradual fall in the temperature of the gases in their passage over the heating surface, to the point of exit at 600° F., and a horizontal line at 362° F. represents the boiler temperature due to a pressure of 143 lbs. per square inch, thus showing a difference of 238° between these two temperatures. The practice which aims at securing an equal temperature throughout a boiler necessarily prevents the gases being cooled below 362° F., but with another construction there may be different temperatures at different parts of the apparatus without detriment to it. Causing the feed-water to flow in a counter-current to the hot gases enables economy to be realised by lowering the temperature of the escaping gases which come into contact with feed-heater or economiser surfaces of a lower temperature than 362°. Superheat can also be added to the steam at the hot end of the diagram. Bringing the feed-water in at the hot end, or at the part of the boiler nearest the fire, causes a lowering of the temperature of combustion, although the water is heated up more rapidly by this method. To secure the maximum transmission of heat from gases to water, they must flow in opposite directions, and evaporation must be completed in a single circuit, no recirculation of water once raised to the boiling-point being allowed, and a constant rapidity of flow being maintained.

"The diagram demonstrates that the functions of the economiser, the boiler and the superheater are but separated parts of a single progressive operation which can be more perfectly accomplished in one apparatus." The general principle is that of heat recuperation, first proposed by Stirling in 1816 ; applications were attempted by Belleville in 1856, Herreshoff in 1878, and Yarrow in 1898. Both Belleville and Herreshoff started with the counter-current principle and progressive evaporation, but failed through using a pump to maintain constant flow. Belleville abandoned this principle, and developed his boiler on that of supplying the water at the hot ends of the coils and adopting a gravity circulation. Yet this boiler, after twenty-two years of use and six years in the British Navy, has now been condemned by a British Parliamentary Committee, and at the opening of the twentieth century the steam-generating problem is still before us.

The principal conditions involved in the evolution of a satisfactory steam-generating apparatus are thus stated :—(1) The water and gases must flow in opposite directions to secure the maximum transmission of heat. (2) The flow must be constant and at maximum speed to obtain the highest efficiency of the surface and prevent overheating. (3) There must be no re-circulation of the water, evaporation must be secured in one circuit. (4) The steam must flow directly from the hottest part of the furnace to the steam reservoir without passing through the water. (5) The steam supply must be separated from the water so that priming, foaming, or lifting will be impossible. (6)

There must be sufficient steam and water room to prevent excessive fluctuations in pressure and water-level. (7) The internal surfaces must be kept clean automatically, and the external surface must be perfectly accessible. (8) There must be no fluctuations in the temperature of the metal, and the flow of feed-water on to hot surfaces must be made impossible. (9) There must be perfect flexibility to permit independent expansion of each part. (10) The apparatus must be simple, with fewest and best joints, and arranged to permit ready access to every part. (11) The apparatus must, with ordinary care, be absolutely reliable in operation, under adverse conditions. (12) The apparatus must be durable without frequent repairs, and with freedom from leaks. An "evaporation diagram," illustrating the action of the Parker steam generator (see Abstract No. 2235) is given to demonstrate the adherence of this boiler to these conditions. F. J. R.

2231. *Superheated Steam.* **G. A. Hutchinson.** (Mech. Eng. 7. pp. 810–812, June 8; 877–880, June 22; 8. pp. 61–64, July 13; 82–84, July 20; 131–133, July 27, 1901. Paper presented at the Milwaukee meeting (May, 1901) of the American Society of Mechanical Engineers.)—The use of better material in the construction of the superheater, of mineral oils having high ignition points for lubrication, and of asbestos or metallic packing, have now made the use of superheated steam practicable. Experience has, however, shown that with engines of ordinary design the temperature of superheated steam should not exceed 475° F. at the engine, as the lubrication difficulties are greatly increased beyond this point.

The equation for superheated steam is $pv = 93{\cdot}5T - 971p^{\frac{1}{4}}$, in which p is the absolute pressure in lbs. per square inch, v is the volume in cubic feet, and T is the absolute temperature in degrees F. With a feed-water temperature of 100° F., 1125·5 B.Th.U. are required per lb. to evaporate it at 150 lbs. pressure. A further addition of 112·6 B.Th.U. will superheat to 600°. So that 10 per cent. additional heat increases the volume of the steam 33⅓ per cent. Superheated steam being approximately in the condition of a perfect gas its specific heat is low: at constant pressure it is about 0·4805, while for air it is 0·2375. The superheat is soon lost by expansion. In engines, experience has shown that 125° to 175° of superheat are required to prevent condensation before cut-off. With low pressures an initial temperature of 650° is necessary in order theoretically to permit of superheat in the exhaust.

An example, by C. Jacobi, of the effect of different degrees of superheat in three tests of a 20-h.p. non-condensing engine is given, and a table of thermal efficiencies of simple and compound engines.

Tests of engines with superheated steam have also been made at Mulhausen, and by R. Doerfel (see Zeitschr. des Ver. Deut. Ingen. Dec. 9 and 16, 1899). In general they show an economy with compound as against triple-expansion engines and a saving in heat with the use of superheated steam. With old engines the superheating could best be effected with highly superheated steam introduced into the heating coils of the receiver and passing thence to the throttle valve. With superheating, no more condensing water need be used by the engines and the danger of admission of priming water into the cylinders is removed. The addition of a superheater is equivalent to an increase in boiler capacity. In using superheated steam in pipes designed for saturated steam there will be a less difference of pressure between the two ends of the main. With a speed of 100 feet per second there will be no more loss in pressure than with a speed of 60 feet for wet steam. The loss by radiation may be 1° F. for 2 feet of pipe, but has been reduced to 1° for 6 lineal feet by using a good thick covering, a high steam speed and small radiating surface.

Any kind of superheater may either be fired independently or by means of waste gases in boiler flues. The latter is more economical. When firing the boiler to raise steam the coils must be protected either by dampers or by flooding them with water. This latter has the disadvantage that mud or scale from the feed-water may be deposited in them and water hammer effects may also be experienced. Dampers are therefore preferable. To place the superheater in the chimney or in the main flue would involve too high a temperature of escaping gases for heat economy if the degree of superheat were to be useful. If placed too near the fire the coils would rapidly become overheated. A good superheater should have (1) security in operation, or a minimum danger of overheating, (2) economical use of heat applied, (3) no exposure of joints to the fire, (4) provision for free expansion, (5) disposition such that it may be cut out or repaired without interfering with the operations of the plant, (6) ease of application to existing plants. The tube elements may be arranged either in series or in parallel. In parallel, as in the Gehre superheater, the proportion of heating surface to quantity of steam is large, and the speed is not great. In series, as in the Schwoerer, the cross-sectional area must be larger, and the steam speed higher. High velocity is good if the volume of steam is not too large for the surface. Both parallel and counter-current flow are made use of, sometimes, as in the Schmidt apparatus, combined in the same device.

The design and construction of the following superheaters are described, viz., the Hering, Walther, Steinmuller, Reisert, Meyer, Gehre, Simonis and Lanz, Buttner, Gohrig and Leuchs, Dürr, Göhring, Hildebrand, Fehrmann, Schwoerer, and Bohmer. They show the variety of ways in which superheating steam has been carried out. Details of working are, however, not given, except in the case of the Schmidt system. Of the Schmidt, Gehre, Walther, and Hering, hundreds of installations have been made, and over 2,000 of the Schwoerer. In fact, it is stated that nearly all the leading German boiler-makers now find it necessary to have some kind of a superheater to offer. This indicates the tendency of the times. Tests are given of a 3,000-h.p. four-cylinder vertical triple-expansion Sulzer engine, using steam which is described as highly superheated, moderately superheated, and saturated respectively. The steam consumption per h.p.-hour varied from 9·56 lbs. with high superheat to 11·75 lbs. with saturated steam. F. J. R.

2232. *Powdered Fuel for Boiler Furnaces.* (Eng. News, 45. pp. 452–453, June 20, 1901.)—Having tried the use of powdered fuel in firing a 250-h.p. Stirling (American) boiler, the Alpha Cement Company erected the plant described and illustrated in this article. It comprises a crusher, in which the raw coal (of bituminous slack or other cheap quality) is pulverised to the size of "rice" or "buckwheat" coal (about equal in grain to "pearls"); a drying furnace, which is used when the coal contains above 6½ per cent. of moisture; a grinding machine, an air separator, with the necessary elevators and storage bins, and a burner through which the dust fuel is admitted to the boiler furnace. The grinder and air separator are of novel design, the former using the crushing action of metal balls which are held loosely in pockets in the circumference of a rotating disc enclosed by a steel ring, and the latter having a fan ingeniously arranged to lift the fine dust from a central shoot to an external annular chamber, whilst the coarser particles fall down the central passage and return to the grinder. The finished dust is fed automatically by a vertical pipe from the storage bin to the burner, which is a short horizontal pipe with a centrally placed nozzle for a jet of compressed air. The air and coal dust issue well mixed and burn very much like a stream of gas issuing at some speed from an orifice.

Results of tests are given. It is stated that the best combustion results were obtained when the coal was ground so fine that 90 per cent. would pass through a 150-mesh sieve. The chief drawback to the use of dust fuel is that on account of the risk of "spontaneous combustion" (so-called) on the one hand, and of its tendency to absorb moisture from the air on the other, it cannot be stored in a finely ground state with safety or efficiency. The object of the apparatus described is to provide means for powdering the coal as rapidly as it is wanted, and keeping only a trifling quantity stored.

In most cases the cost of pulverising amounts to from 10 to 25 cents [5d. to 1s.] per ton. The machinery for crushing, grinding, and separating 75 to 100 tons of coal per 24 hours requires about 25 h.p., or less than 1 per cent. of the power produced by the coal when burned under a boiler to raise steam. F. J. R.

2233. *Deposits in Steam Boilers.* **W. E. Ridenour.** (Frank. Inst., Journ. 152. pp. 113–118, Aug., 1901.)—This author deals with the chemical constitution and physical appearance of various salts existing in boiler deposits.

In estimating the quantity which accumulates in a boiler during a month's work, he bases his figures upon the following analysis of clear water from the Schuylkill, much used in Philadelphia :—

	Grains per U.S. gallon.
Organic and volatile	5·060
Calcium sulphate	3·560
Magnesium sulphate	0·602
Sodium chloride	1·167
Calcium carbonate	0·357
Solids	10·746

The scale-forming ingredients amount to 4·519 grains per gallon, and for 1,000 h.p., using 4 gallons evaporated per hour per h.p., the amount of accumulated solid is 1,040,000 (No. of gallons per month) × 4·519 = 4,699,760 grains or 671 pounds of sediment per month.

Some waters from wells average from 25 to 75 grains per gallon, and one specimen showed 88 grains per gallon, which of course give a much worse result than the above.

Calcium scales are generally hard and porcelain-like, though some are soft. They can generally be distinguished by their vitreous appearance. V. B. Lewes (Chem. News, 1899, 59–222) maintains that the sulphate is first deposited as a hydrate, $CaSO_4.H_2O$, which forms the anhydride $CaSO_4$, by the action of the heated plates. This author has always found the anhydride existing in deposits, of which the following is an example :—

	Per cent.
Moisture at 100° C.	0·23
Calcium sulphate	94·89
Magnesium hydrate	1·98
Silica	0·25
Organic and undetermined	2·65

Calcium carbonate deposits are usually soft, but acquire different degrees of hardness by admixture with magnesia, calcium sulphate, or silica ; when moderately pure, however, they are distinctly crystalline, this appearance being maintained in deposits containing only 51·73 per cent. of carbonate. In *Silicate scales* there is a combination of calcium oxide and silica, existing as calcium silicate, formed probably by boiling under pressure, the free silicic acid in the water reacting on the calcium carbonate. Several analyses of such deposits are given ; the following, with that of the water from which it was found, being the most interesting :—

	Per cent.	Calcium silicate.
Calcium oxide	5·42	5·42
Silica	48·02	5·80
		11·22
Calcium sulphate	8·95	
Magnesium hydrate	8·58	
Iron oxide and alumina	27·08	
Organic and undetermined	11·95	

Analysis of the water—

	Grains per U.S. gallon.
Calcium carbonate	1·311
Calcium sulphate	0·104
Magnesium carbonate	1·147
Sodium chloride	0·850
Silica	1·469
Organic and volatile	1·340
Solids	6·221

The *Magnesia deposits* have no distinguishing characteristics under the microscope, and are variously supposed to contain the oxide, hydrate, or carbonate. The author thinks the hydrate is the most usual, although he has found carbonate in some specimens. The carbonate is probably first deposited, and is changed by the heat to which it is exposed into the hydrate, or even the oxide. In fact the composition of deposits from the same water in different parts of a boiler is much affected by the temperatures at which they have been formed. F. J. R.

2234. *Boiler Trials on H.M.S. "Hyacinth" and "Minerva."* (Engineering, 72. pp. 283–285, Aug. 30, 1901.)—This is the Report of the President of the Boiler Committee on the performance of the Belleville boilers of the *Hyacinth* and the cylindrical boilers of the *Minerva* during a trial voyage to Gibraltar and back to Portsmouth. It is simply a record of the facts and incidents of the trial, but no opinion is added to the results.

The serious loss of water by leakage from the joints of the Belleville boilers and the choking of the fire tubes of the Scotch boilers by "bird-nesting," are the most prominent results manifested.

On the outward run the average h.p. of the *Hyacinth* was 7,047 for 108¼ hours, with a coal consumption of 1·97 lbs.—the distance run having been about 1,810 miles at an average speed of 17·6 knots. The *Minerva's* h.p. was 7,007 for 147 hours with a coal consumption of 2·06 lbs. : the distance run was about 2,640 miles at an average speed of 17·96 knots.

Tabular statements of results of trials carried out prior to the departure for Gibraltar, and of the results of the examination of the boilers of the *Hyacinth* on her return to Portsmouth, are given. F. J. R.

2235. *Parker Steam Boiler.* **H. G. Morris.** (Eng. Club Phil., Proc. 18. pp. 137–146, July, 1901.)—This is a straight tube boiler with reversed circulation, the water flowing downwards as it becomes heated, whilst the steam is taken off at the lowest point and is discharged directly into a dry steam chamber kept apart from the water. The gases flow upwards from the fire so that the hottest gases and water meet first. A 150-h.p. unit has 1,500 square feet of heating surface, and 31·5 square feet of grate surface. A single drum 42 inches diameter and 20 feet long is divided longitudinally by a diaphragm into upper and lower, or steam and water chambers, the lower being connected at the rear of the boiler to the "dished head," and at the front to a casting or steam space head in the upper chamber, an opening being provided into the lower one, 11 inches by 15 inches, controlled by a swinging non-return valve. There is also a small by-pass between the steam space of the lower or water chamber and the dry-steam chamber.

There are 96 horizontal tubes, 3 inches diameter and 18 feet long, arranged in vertical groups to form flattened spirals. There are 6 elements, each two tubes wide, composed of 16 tubes expanded into malleable iron junction boxes which form the bends of the spirals. The shape and arrangement of these boxes, with their hand holes, leaves four openings 1⅞ inches square round each tube for brushing soot and dust. The upper ends of the elements are connected by short nipples to the vertical junction boxes and to a steel cross-box which is riveted to the under side of the drum. A brass disc is suspended in each of these vertical boxes in front of the nipple, and acts as a check valve against reversals of flow of water and steam. The lowest tube of each element is connected to a horizontal steel cross-box, or steam collector, which delivers all steam through two upcast pipes to the dry-steam chamber. The baffles of firebrick tiles, 1½ inches by 4½ inches by 9 inches, rest on the third and eighth rows of tubes.

The water is fed into the drum or cross-box, flows into the tubes and seeks its level in upcasts and drums—the working level being 2 to 12 inches below the diaphragm. When heat is applied, the water in the upcasts is driven out by steam, and the heavier column of water in the drum and tubes causes the flow downwards, the water being heated during its descent, and forming steam by the time the upcast is reached. A sudden withdrawal of steam from the steam-chamber causes the swinging valve to shut and prevent priming, the excess of pressure in the lower chamber serving to maintain the circulation.

This boiler can be fired from both ends. In a 500-h.p. double-ended unit the drum is 60 inches diameter and 20 feet long. The elements are single instead of double, with boxes vertical at both ends, giving 96 square feet of grate surface and 5,000 square feet of heating surface, on a floor space, including 17-inch walls, of 8 ft. 10 in. by 18 ft. 10 in. A vertical design can also be used if necessary, and a boiler of the two-drum horizontal design has been worked at Roach's shipyard at Chester, Pa., since April, 1900. F. J. R.

AUTOMOBOLISM.[1]

2236. *Alcohol as a Source of Motive Power.* (Locomotion Automobile, 8. p. 503, Aug. 8, 1901.)—This paper gives the results of experiments by Behrend at the Technical Institute of Hohenheim on the use of alcohol in a

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[1] Electric Automobiles are described in the section dealing with electric traction.

Koerting engine of 6 h.p. nominal. Three mixtures of alcohol were employed, viz.:—(1) Alcohol denaturalised in the ordinary manner for commercial purposes. (2) Alcohol with benzine added to the extent of half the volume of the ordinary denaturalising agent. (3) The same mixture as (2) with an addition of 18 per cent. of benzine. The results were as follows:—

Mixture.	Quantity consumed per b.h.p.-hour.	Cost of spirit per b.h.p.-hour.
(1)	0·595 kg.	0·149 fr.
(2)	0·585 „	0·146 „
(3)	0·519 „	0·130 „

The cost of alcohol is taken as 25 fr. per hectolitre, and this is reduced by 0·337 fr. per hectolitre by the addition of benzine. The cost of running, when petrol is employed, is about 0·125 fr. per b.h.p.-hour. C. R. D'E.

2237. *Wheels and Tyres for Motor Trucks.* **W. L. Bodman.** (Horseless Age, 8. pp. 359–360, July 24, 1901.)—The author considers that it is impossible to obtain sufficient adhesion under many conditions of road surface, without the use of rubber tyres, on the driving wheels of a heavy lorry. The following points are mentioned as essential for the success of solid rubber tyres:—(*a*) Ample width of tread so that load may not exceed 650 lbs. per inch width. (*b*) Largest possible sectional area without liability to roll. (*c*) Perfect fixing to prevent creeping. (*d*) Smallest proportion of waste material for fixing tyre. A simple form of tyre-testing machine is illustrated, and also the method of construction of certain types of disc wheels and fixing rubber tyres thereto. C. R. D'E.

2238. *Shaffer Boiler and Engine.* (Horseless Age, 8. pp. 316–317, July 3, 1901.)—This boiler, which is intended for use in light steam cars, is constructed with two concentric cylindrical shells joined by end-plates. The water and steam spaces are between the shells, and the main flue passes up the central cylinder. Projecting from the water space into the central flue are water tubes of U form, placed vertically so that one leg enters the upper part of the water space, and the other leg enters the lower part. The steam is superheated in tubes which extend across the upper part of the central flue. Before escaping, the products of combustion are led down round the exterior of the outer shell. The shells are 10 inches and 14 inches diameter respectively and 14 inches high. The working pressure is 200 lbs. per square inch, and the boiler is rated at 4½ h.p. Its weight is stated to be about 60 lbs.

The engine is of the two-cylinder coupled vertical type, with a 2¾-inch bore and a 3-inch stroke. All working parts are enclosed and plain bearings are used throughout. A special feature is the reversing-valve motion, in which both the slide valves are operated from one eccentric. C. R. D'E.

2239. *Riker Gasoline Carriage.* (Horseless Age, 8. pp. 310–311, July 3, 1901.)—This is a new American car, built very much on the lines of the French vehicles. The engine is mounted towards the front of the underframe and, together with the water-tank, is enclosed by a sheet-steel bonnet. It has two vertical cylinders with pistons coupled to cranks at 180°. The cylinders are 4-inch bore, with 4-inch stroke; and 9 b.h.p. is developed at 900 r.p.m. The carburettor is of the type in which a combined air and petrol control valve is lifted by the suction of the cylinders, and returned to its seatings by a spring. High-tension electric ignition is employed, with a separate coil for each cylinder. The cooling water circulation is maintained by a pump, and a radiator is mounted at the front of the bonnet. The power is transmitted from the crank-shaft through a special epicyclic gear, and a bevel drive, to a cross countershaft, and thence by chain gears to the road-wheels, which run on the ends of a fixed axle. By means of the epicyclic gear, three forward and one reverse speed are obtainable at a fixed speed of the engine. The wheel base is 5 ft. 6 in., and gauge 4 ft. 2 in., and the weight of the car is about 1,675 lbs. with tonneau body. A side elevation of the car and details of the carburettor and change speed gear are given. C. R. D'E.

2240. *Millot Carriage.* (Automotor Journal, 5. pp. 482–483, July, 1901.)—In this car a rectangular underframe carries near its front end a double-cylinder petrol engine. The power is transmitted from the engine to the change speed gear by means of pitch chains, and again from the change gear to the road-wheels by chain drives. The special feature of the design lies in the form of change speed gear employed. An aluminium gear-box encloses two parallel shafts, upon each of which is mounted an ordinary bevel wheel and pinion differential gear. The sleeves carrying the bevel wheels of the first differential gear project outside the gear-box, and upon each is mounted a sprocket pinion which may be caused to drive its sleeve through a roller clutch. Each sprocket and sleeve is driven independently from one end of the crank-shaft of the engine, which lies parallel with the gear-box shafts and at right angles to the length of the car. The roller-clutches permit of rotation of the differential sleeves in the direction of rotation of the engine only. On the exterior of the box of each differential gear is a toothed ring, and these are always in mesh for forward movement of the car. The second differential shaft is so mounted that an eccentric movement may be imparted to it, which brings its toothed ring either into or out of mesh with that of the first shaft. The movement which puts the toothed rings out of gear at the same time introduces a spur pinion which meshes with both and so gives the reverse motion. The three forward speeds given by the gear are obtained as follows: For the lowest speed the roller-clutch on the right-hand sprocket is thrown into gear, the bevel of the differential gear on this sleeve then rotates at a speed relative to the engine, which is determined by the ratio of the chain-drive. The other bevel of this gear tends to rotate backwards, being driven through the bevel pinions of the gear. The roller-clutch on its sleeve will, however, not permit of this, and the result is that the box of the differential gear with its toothed ring rotates at half the speed of the driven sleeve. The motion is transmitted to the other gear and its shaft by the spur-rings, which are now in mesh, and so to the road-wheels of the car. The intermediate speed is obtained by throwing the roller clutch of the left-hand sprocket into gear, the movement being then similar to those which give the slow speed. To obtain the highest speed both roller clutches are thrown in, then the box of the first gear is driven at a speed which is the sum of the speeds at which it would be driven when one or other clutch is engaged. The shaft which carries the second gear is connected by flexible couplings to the short shafts, which carry the sprocket pinions of the road-wheel chain-drives. This permits of the eccentric movement of the differential shaft, which is required for the reversing mechanism. C. R. D'E.

2241. *Sweet Engine.* (Locomotion Automobile, 8. pp. 474–475, July 25, 1901.)—This is a small, enclosed-type, compound steam engine with cylinders at right angles, the h.p. being horizontal and the l.p. vertical. The two pistons are coupled to a single crank, and ordinary flat slide-valves are employed. By means of a special form of cock, high-pressure steam may be admitted direct to the l.p. cylinder. A sectional elevation of the engine is given. C. R. D'E.

REFERENCES.

2242. *Superheated Steam.* **E. H. Foster.** (Eng. Record, 43. pp. 325–327, April 6, 1901. Paper read before the Amer. Soc. Mech. Eng. April 2, 1901.)—A short review dealing with the subject generally. H. R. C.

2243. *Balancing of Engines.* **W. E. Dalby.** (Engineering, 71. pp. 457–459, April 5; 490–492, April 12; and 521–523, April 19, 1901. Paper read before the Institution of Naval Architects.)—A full account of the balancing of the reciprocating parts of multiple crank engines, including the effect of obliquity of the connecting-rod. H. R. C.

2244. *Revealer for Studying Condensation in Steam-engine Cylinders.* **B. Donkin.** (Inst. Mech. Engin., Proc. 4. pp. 509–532; Discussion, pp. 532–553, 1900.)—Description of an improved form of glass revealer and of a series of experiments with it. H. R. C.

2245. *Assistant Cylinder.* **D. Joy.** (Engineering, 71. p. 438 and pp. 442–444, April 5, 1901. Paper read before the Institution of Naval Architects.)—A short account of some improvements in Joy's "Steam Assistant Cylinder" for valve-gears. H. R. C.

2246. *Steam Heating Plant.* (Eng. Record, 44. pp. 86–88, July 27; 108–110, August 3; and 134–136, August 10, 1901.)—Very full particulars are given of the arrangements for heating and ventilating the buildings on Ellis Island, New York Harbour, and the steam-piping is described in detail. There is an electrical plant of 425 kw. capacity, the exhaust steam from which is used for heating. A. H. A.

2247. *Methods of Varying the Power of Petrol Motors.* **G. Lavergne.** (Locomotion Automobile, 8. pp. 529–530, Aug. 22, 1901.)—A review of the available methods of varying the power developed by a petrol motor, viz., by varying (1) the quantity of charge drawn in per stroke, (2) the point of ignition, (3) the pressure of compression. C. R. D'E.

2248. *The Motor Car and its Future.* **A. G. New.** (Feilden, 5. pp. 34–50, July, 1901.)

GENERAL ELECTRICAL ENGINEERING.

2249. *Economical Value of Electrical Energy, and the Electrical Production of Combustible Gas.* **O. Schmidt.** (Zeitschr. Elektrochem. 7. pp. 807–809, Aug. 1, 1901. Paper read before the Deutsch. Elektrochem. Gesell. at Berne, July 6, 1901.)—Comparing coal and electricity as sources of heat energy, the author arrives at the result that, on the average, only 30 per cent. of the energy is utilised in the former case; whereas in the latter this percentage is 90.

In the manufacture of water-gas he recommends electrical heating, instead of the usual process of supplying the necessary heat by blowing in air and burning up part of the coke. In this way he calculates that a saving of over 33 per cent. of the coke can be effected. The conclusion is arrived at that it would be cheaper to supply water-gas than electricity, now that the necessity for a luminous flame has very largely ceased to exist, owing to the widespread use of Welsbach burners. The author is of opinion that it would be easy to adapt carbide furnaces to the manufacture of water-gas. Finally, he considers the possibility of dispensing with coal entirely, and supplying the gas-works with pure hydrogen obtained by electrolysis.

[The calculations are founded on the economical conditions existing in Switzerland.] F. G. D.

2250. *Measurement of Power taken by Three-phase Motors.* **G. Stern.** (Elektrotechn. Zeitschr. 22. pp. 539–542, July 4, 1901.)—In measuring the power supplied to three-phase induction motors, it is generally assumed that the three phases take equal currents, which exhibit equal phase differences. This assumption leads, in the case of three-phase supply meters intended for motor circuits, to forms of construction which are simpler than those used in connection with unbalanced three-phase circuits. The author points out that with a mixed lighting and power load the p.d.'s across the three branches of the network are in general unequal, and hence the currents taken by the three circuits of a motor will also be unequal, and will have phase differences other than 120°. He calculates the maximum possible error of measurement, with meters of simplified construction based on the assumption of equality of the three p.d.'s (assuming the differences of p.d. to be so small that no appreciable change of apparent impedance results), and finds that this error expressed as a percentage always exceeds the percentage difference between the p.d.'s. A series of careful measurements is given which confirms this result, and the author concludes that the use of approximate methods of power-measurement (based on assumption of equality of p.d.) should be abandoned in the case of three-phase supply meters and wattmeters. A. H.

2251. *Influence of Temperature on Accumulator Capacity.* **M. U. Schoop.** (Zeitschr. Elektrotechn., Wien, 19. pp. 353–356, July 21, and pp. 362–364, July 28, 1901.)—Experiments were made with cells in which the temperature of the acid was raised to 60° C. The general effect was to increase the capacity. A cell, for example, which had at 15° C. a capacity of 36·9 ampere-hours, when raised to 60° C. had its capacity increased to 55 ampere-hours. The increase of conductivity and diffusivity of the electrolyte accounts for the greater energy efficiency which was also noted. W. W. H. G.

2252. *The Edison Accumulator.* **F. Peters.** (Centralblatt Accumulatoren, 2. pp. 185–188, July 1, 1901.)—The new invention of Edison is described, and the details furnished by A. E. Kennelly [see Abstract No. 1775 (1901)] to the American Institute of Electrical Engineers are discussed. He calculates that Edison's cell requires 9 sq. dm. of electrode surface for each kg. of cell, which is at least twice as great as in the case of the lead automobile type of cell. Further, for a given pressure, the mean voltage being 1·1, about double the number of cells will be necessary. He considers the positive electrodes are much too compact, and makes other adverse criticisms. W. W. H. G.

2253. *Nickel Oxide Alkaline Cells.* **A. L. Marsh.** (Elect. World and Engineer, 38. p. 136, July 27, 1901.)—Particulars are given of the various oxides of nickel and their method of preparation. The author is of opinion that nickel peroxide, NiO_2, is the real depolarising agent in Edison's Iron-Nickel oxide accumulator, being electrolytically reduced on discharge to nickel sesquioxide, Ni_2O_3. E. J. W.

2254. *Marino Accumulator.* **W. Hibbert.** (Elect. Rev. 49. pp. 131–132, July 26, 1901.)—This cell is built up of horizontal lead electrodes, containing the usual active materials, and kept apart by porous separators. Its chief feature is the use of dilute phosphoric acid as the electrolyte, and the chief interest of the article consists in the curves and particulars given of the conductivity of phosphoric acid solutions of various strengths, and of the e.m.f.'s they furnish with lead-lead peroxide electrodes. E. J. W.

2255. *Indiarubber Strip.* **H. L. Terry.** (Electrician, 47. pp. 662–663, Aug. 23, 1901.)—A strip is either "cut" or "spread," the later being cheaper. The raw material and its washing and drying are the same in both cases. For *cut sheet*, the dry rubber is compressed between steel rollers, and passed through a masticator similar to Hancock's original machine. The block of rubber is then subjected to hydraulic pressure, frozen hard by chemical means, and cut into sheets by a special machine. For *spread sheet*, the dry rubber is dissolved in coal-tar naphtha, spread on a length of cloth, the naphtha evaporated by passage over a steam chest, and the spreading repeated until the required thickness is obtained. The author points out that the failure of pure rubber to keep sulphur from the copper of cables has led in some cases to the substitution of cellulose. M. O'G.

2256. *Variable-Tariff Meters.* **G. Goisot.** (Écl. Électr. 28. pp. 27–30, July 6, 1901.)—This article gives descriptions of a number of the above meters. The first is that of G. Rasch, of Carlsruhe, in which the shunt-coils of the meters are put in series, during the time of low tariff, *i.e.*, early in the day and late at night, with a resistance at the central station, a special conductor being provided for this purpose.

An early form of Aron meter is also described, in which the current through the shunt or pendulum coil is supplied, during the time of high tariff, by a special generator. At the time of low tariff, this current is raised until an automatic cut-out is operated, which puts the shunt-coil across the mains, at the same time disconnecting it from the special generator. The two-tariff clockwork Aron meter is then referred to [see Abstract No. 1572 (1901)].

In the Union Elektrizitäts Gesellschaft meter (German patent No. 99021), there are two counting trains, one of which is always in gear with the motor, whilst the other is thrown into and out of gear by a clutch controlled by an electromagnet, the circuit of which is made and broken by a switch driven by a clock, so as to register at the time for which there is a special tariff.

In the Loubery, François and Kunkelmann meter, which is a motor-meter, a master-clock at the central station completes circuits including an electromagnet in each meter. The pole-pieces of this electromagnet are arranged on opposite sides of the damping disc of the meter, so that the rate of the meter is altered when the electromagnet is energised. Or the master-clock can act through a relay to complete a local circuit. Other arrangements are also suggested. C. K. F.

2257. *Electric Elevator in the Washington Monument.* **C. M. Lewis.** (Elect. World and Engineer, 38. pp. 176–179, Aug. 3, 1901.)—An Otis elevator worked by a steam engine formerly conveyed passengers to the top of the monument, which is 555 feet high. The original elevator car, with safety devices, &c., weighed 6,500 lbs., and when carrying a normal load of 6,000 lbs. the net load on the hoisting drum was 12,500 lbs. By substituting electric machinery and a counterweight system the weight of the car, safety devices, &c., has been reduced to 5,670 lbs., and as the weight of the drum counterbalance is 8,040 lbs. that leaves a net overbalance on the hoisting drum of 2,370 lbs. when the car is empty. With the maximum load of 6,000 lbs. in the car the net load on the hoisting drum to be lifted by the winding mechanism is now 3,630 lbs. This at 100 feet p.m. is equivalent to 11 h.p. as compared with the 18·9 h.p. required for gravity work in the old car. The new system can therefore lift the same live load at double the car speed with 58 per cent. of the energy formerly required, and leave sufficient power to light the monument and grounds with electric light, without increasing the number of boilers or of employés at the monument. The power-house was enlarged and a duplex compound steam engine of the tandem marine type, with a 240-volt continuous current direct coupled generator, was installed in it, copper cables being run to the switchboards for the elevator motor and the electric lights at the monument. The electric generator has a capacity of 50 kw. at 275 r.p.m. The cylinder dimensions of the engine are 9½ and 15 by 11, and the guaranteed consumption of steam is 27 lbs. per i.h.p.-hour. There are complete fittings to the switchboards, and in this paper photographs of the machinery are reproduced, with minute descriptions.

The principal novelty consists in the "safety" apparatus of the car, which works on a smooth web of steel T-rails or vertical guides. The gripping mechanism is controlled by wedges at both sides of the car, which force open the jaws of gripping levers, these wedges being drawn together by means of a spring acted upon by a right- and left-handed screw safety spindle, which begins to revolve as soon as the speed of the car exceeds the normal rate. The safety mechanism can be operated from the car and can also be made to stop the car whilst ascending or descending.

The guaranteed efficiency of the whole elevator system was 40 per cent. at maximum load, and an efficiency of 41·09 per cent. from the electrical energy delivered to the controller was obtained on test. F. J. R.

2258. *Becker's Electric Clock.* (Engineering, 72. pp. 117–118, July 26, 1901.)—This is a secondary clock adapted to be operated by an impulse every half-minute from a master-clock; there is a ratchet-wheel on the minute-hand arbor, this ratchet-wheel being operated by a pawl on a rocking-lever moving between fixed stops and controlled by an electromagnet. The feature of the mechanism consists in an "inertia stop," which is rigidly mounted on the rocking-lever and acts in conjunction with a retaining-pawl, so as to lock the ratchet-wheel when the rocking-lever is displaced by the electromagnet. For this purpose, the inertia-stop, as it moves out of engagement with and thereby releases the ratchet-wheel, moves over the retaining-pawl and holds it closely in engagement with the ratchet-wheel. By this means the effects of wind-pressure on the hands, &c., during the displacement of the rocking-lever are rendered harmless, and the hands can only be moved by a complete back and forward stroke of the rocking-lever. The action of gravity on the rocking-lever is assisted by a spring, so as to ensure that there shall always be sufficient energy available, on de-energisation of the electromagnet, to move the hands. C. K. F.

REFERENCES.

2259. *Electric Cranes.* **W. Müller.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 691–694, May 18, 1901.)—A description, with drawings, of two cranes lifting 25 tons and 50 tons respectively, and driven by direct current at 500 volts.
W. H. E.

2260. *Calculating the Capacity of a Battery for a given Output.* **K. Norden.** (Elect. World and Engineer, 37. pp. 396–397, March 9, 1901.)—The author gives a graphical method of calculation based on a known or predetermined output, or discharge curve, taking into account the variation of capacity with rate of discharge.
C. K. F.

2261. *Cahill Electric Typewriter.* **B. C. Washington, Jr.** (Elect. World and Engineer, 37. pp. 763–764, May 11, 1901.)—Description of a typewriter with electrical action. C. K. F.

2262. *Electric Coal-tip at Rotterdam.* (Zeitschr. Vereines Deutsch. Ing. 45. pp. 793–805, June 8, and 835–845, June 15, 1901.)—A very complete description of a coal-tip, which has been constructed by Nagel and Kaemp, and erected on the harbour at Rotterdam for the purpose of loading and unloading coal. The article contains more than one hundred drawings, showing details of construction, &c.
W. H. S.

2263. *Electricity in the Ship-yard.* **J. H. Biles.** (Eng. Mag. 21. pp. 525–547, July, 1901.)—An article containing illustrations of some electrically-driven machinery.

2264. *Electrically-driven Machine Tools.* **C. B. Nixon.** (Inst. Elect. Engin., Journ. 30. pp. 1200–1207, Aug., 1901.)—The author describes two of the power-stations of the Lancashire and Yorkshire Railway, viz., those at Newton Heath and at Oldham Road, Manchester. He also gives figures showing the results of working, and concludes by giving a list showing the power taken by machinery of different kinds, installed in the works under notice.

GENERATORS, MOTORS, AND TRANSFORMERS.

2265. *Maximum Efficiency of Dynamos.* **L. Finzi.** (Elektrotechn. Zeitschr. 22. pp. 634–635, Aug. 8, 1901.)—Assuming that the total losses occurring in a loaded machine consist of two parts, one of which is a constant (no-load losses), while the other increases with the square of the current—an assumption which is justified by experiment—the author shows that maximum efficiency is reached with that value of the current for which the two kinds of losses become equal. A. H.

2266. *Rise of Temperature in Field-coils of Dynamos.* **E. Brown.** (Inst. Elect. Engin., Journ. 30. pp. 1159–1199, Aug., 1901.)—In this paper the author describes a series of experiments which he carried out in order to ascertain the distribution of temperature in the field-coils of dynamos under various conditions. The experiments were made with a Siemens dynamo, of which the output was 55 amperes at 135 volts at a speed of 1,250 r.p.m. This was run as a motor, with a current of 2½ amperes maintained constant through the experimental field-coil, while the armature ran either light or loaded, and at different speeds. The temperature was measured in each case, after five hours' steady run, by measuring the increase of resistance of pilot wires of known temperature coefficient and resistance, which were fixed in position during the winding of the coil at three different depths, and in different positions with respect to the longitudinal axis of the coil. Full details of the construction of the experimental coil are given, and also a large number of curves exhibiting the results obtained. These show—(1) The effect of increase of armature speed on the rise of temperature along the vertical layers of the winding, under different conditions of armature load. (2) The effect of increase of armature speed on the rise of temperature through the horizontal depth of winding at points half-way along the axis of the coil, under different conditions of armature load. (3) The effect of increase of armature-current on the rise of temperature along the three vertical layers of the winding, under the different armature speeds. The experiments were all made in duplicate, with the experimental coil first on one limb of the magnet and then on the other, as the fanning action of the armature was different in the two cases. Some interesting results are arrived at, the high-temperature gradients in the winding under certain conditions being specially noticeable. Thus, under normal full-load conditions, the surface rise of temperature observed was 29° C., the average rise in the coil 50° C., and the maximum 60° C. Under certain conditions an increase of current in the armature may actually diminish the temperature of the field-coils. No satisfactory explanation is offered of this curious phenomenon, though it is believed to be connected with convection currents of air produced by the rotation of the armature (as distinguished from the ordinary fanning action).

Amongst the practical conclusions to which his experiments point, the author refers to the desirability of making the end surfaces of the field-coils as thermally conducting as possible, and suggests an increase also in the thermal conductivity of the materials interposed between the winding and the cores. In this connection the advantage of a good fit between the bobbin and the core is emphasised. The suggestion is also made that the field-winding should be made shallower in the middle than at the ends, in view of the much greater rise of temperature noticed in the middle section of the winding. B. P. S.

2267. *Compounding Alternators.* **M. T. Gentile.** (Elettricità, Milan, 20. pp. 51–53, Jan. 26; 195–201, March 30; 340–343, June 1, and pp. 358–359, June 8, 1901.)—The author treats the cases where alternators are excited partially by a continuous current and partially by a rectified current obtained from the secondary of a transformer, the primary of which is in series with the main circuit; also when they are excited by the current from a rotary converter run off a series transformer. In each of these methods compounding can be realised only when the reactance of the armature is negligible. The author then considers Leblanc's method of exciting alternators by means of a synchronous converter [Abstracts Nos. 620 and 908 (1899)], and gives the results of some tests on a slightly over-compounded machine. G. H. B.

2268. *Theory of Short-circuited Alternator.* **F. Horschitz.** (Elektrotechn. Zeitschr. 22. pp. 537–539, July 4, 1901.)—The author assumes sine waves of e.m.f. and current, and supposes that the space-distribution of the magnetic flux due to the field ampere-turns also follows the sine law. Under these circumstances, each point on the armature is subject to the action of two magneto-motive forces, which vary according to the sine law. One of these, that due to the exciting current, has a maximum value equal to the product of the exciting current into the field-turns; while the other, that due to the short-circuit armature current, is equal to the product of the armature turns into the *maximum value* of the armature current. By compounding these ampere-turns, the resultant ampere-turns are obtained. The short-circuit e.m.f. is proportional to the resultant ampere-turns, and must be sufficient to balance both the resistance and the inductance drop in the armature. The author determines the value of the resistance and inductance by obtaining a curve which connects the short-circuit current with the frequency for a given value of the exciting current. Experiments carried out by the author are in almost perfect accord with his theory. A. H.

2269. *Rotating Field of Two-pole Three-phase Winding.* **O. Bergmann.** (Zeitschr. Elektrotechn., Wien, 19. pp. 356–357, July 21, 1901.)—The author investigates the variations in the intensity and direction of the field produced by a three-phase winding, the axes of whose coils make angles of 120° with each other, the algebraical sum of the three currents being zero, but the currents being in general unequal, and their phase differences having assigned values; further, the permeability of the magnetic circuit is assumed to be constant. It is found that in the general case both the intensity and the angular velocity of the resultant field vary, becoming constant in the special case of phase differences of 120° and equal currents. The extremity of the resultant field-vector is found to trace out an ellipse. A. H.

2270. *Predetermination of Short-circuit Current in Three-phase Generators.* **R. Bauch.** (Zeitschr. Elektrotechn., Wien, 19. pp. 373–380, Aug. 4, 1901.)—In calculating the armature ampere-turns of a three-phase generator, it has been usual to take $1{\cdot}5\sqrt{2}Si$ as the ampere-turns, S standing for the numbers of conductors per pole and phase, and i for the r.m.s. value of the current in one phase. The author shows that the factor 1·5 is too small, and that a better agreement with experimentally determined values is obtained by taking the factor $\sqrt{8}$. A. H.

2271. *Calculation of Ampere-turns for Teeth of Armature.* **E. Dick.** (Elektrotechn. Zeitschr. 22. pp. 598–601, July 25, 1901.)—The author first considers the simple case in which the tooth is of uniform thickness, and, treating the iron of the tooth on the one hand, and the slot and air spaces between core discs on the other, as two parallel paths open to the magnetic flux, calculates the joint reluctance of a tooth and slot. Taking next the case of a tapering tooth, he divides up the tooth and slot into a series of parallel layers normal to the flux by cylindrical surfaces co-axial with the armature. Each of these layers—provided its radial depth is not excessive—may be treated as a shallow tooth and slot with parallel sides, and so the exciting ampere-turns for the teeth may be found by a summation of the ampere-turns for the consecutive layers. A. H.

2272. *Determining Hysteresis and Eddy Current Losses in Dynamos.* **E. Strymeersch.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 164–171, July 6, 1901.)—The methods of Housman and Swinburne for determining the hysteresis and eddy current losses in dynamos and motors are described, and the necessary precautions are pointed out. The dynamo is run as a motor at various speeds, the excitation being kept constant, the highest speed corresponding to the e.m.f developed in the dynamo at the load at which the losses are to be measured. Experiment shows that the power lost by eddy currents is proportional to the square of the speed (n), whilst hysteresis and frictional losses are directly proportional to the speed. If E be the applied p.d. and C the current, then the total losses (EC) may be written—

$$\mathrm{EC} = kn^2 + k'n.$$

Since the excitation is constant, $\mathrm{E} = an$; hence—

$$\mathrm{C} = \frac{k'}{a} + \frac{k\mathrm{E}}{a^2}.$$

If we plot out C and E for different values of E we get a straight line. An experiment on a shunt motor is described illustrating the accuracy of this method. The armature and shunt resistances when warm measured 0·074 and 57·1 ohms respectively. When running on its normal load it took 45 amperes at 100 volts. Hence the back e.m.f.—

$$= 100 - \left(45 - \frac{100}{57{\cdot}1}\right) 0{\cdot}074$$
$$= 96{\cdot}8 \text{ volts.}$$

The current at this back e.m.f. was found to be 4·9 amperes. The total losses are therefore 96·8 × 4·9 = 475 watts. Drawing the diagram of current and volts and finding the areas of the triangle and rectangle respectively in the usual manner, it is found that the losses by hysteresis and friction are 194 watts, and by eddy currents 281 watts. A. R.

2273. *Extensions of Swinburne's Method of Testing Dynamos and Motors.* **Brunhes.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 72–93, July 6, 1901.)—Swinburne's method of testing dynamos and motors is to run them at no load under the same magnetic conditions as at full load, and hence to find the losses due to friction, hysteresis and eddy currents. The chief cause of error arises from the difference between the mechanical friction in the two cases. In the case of rotary converters and dynamotors the error due to this difference is negligible. In the formula for calculating the heating in the armature of a rotary converter, $\cos\phi$, the power factor of the alternating current circuit, enters. If we calculate this heating on the assumption that $\cos\phi$ is unity, we get an approximate value of the efficiency (η). Now—

$$\eta VC = n EI \cos\phi$$

where V,C and E,I are the direct and alternating volts and amperes respectively and n is the number of phases. Hence we find an approximate value for $\cos\phi$. Substituting this value of $\cos\phi$ in the formula for the heating the value of η can be found to a second approximation, which is generally sufficiently accurate for practical purposes. When an alternating current transformer is on a non-inductive load and there is no leakage—

$$E_2 = V_2 + R_2 I_2.$$

Hence if we apply by a rotary transformer such a voltage (V_1) to the primary that the secondary volts are E_2, then we can find what the loss in the core of the loaded transformer is, and so find its efficiency. To find the ratio (n) of the back e.m.f. in the primary to the e.m.f. producing the current in the secondary, the following approximate formula is given :—

$$n = \sqrt{\frac{k}{k'}},$$

where k is the ratio of primary volts (V_1) to E_2 and k' is the ratio of the secondary volts required to produce a primary voltage E_1, where E_1 is the back e.m.f. in the primary when the open circuit secondary volts are E_2. In general—

$$k = n\left(1 + \frac{R_1 I_1}{V_1}\cos\phi_1\right) = \frac{V_1}{E_2}.$$

Hence $\cos\phi_1$ can be found, and the efficiency of the transformer calculated without using a wattmeter. If there is no magnetic leakage $n = \frac{n_1}{n_2}$, where n_1 and n_2 are the number of primary and secondary turns respectively. The author says that rotary converters can be usefully employed for measuring the power given to transformers, synchronous or asynchronous motors, &c., or for testing alternators. A. R.

2274. *Artificial Loading of Alternators.* **R. Goldschmidt.** (Elektrotechn. Zeitschr. 22. pp. 682–684, Aug. 22. 1901.)—In order to effect a saving of power in the testing of large alternators, it is convenient to run them at full excitation, so as to obtain the full iron losses, and to produce heating of the copper by sending the full-load current through the armature coils from an independent continuous-current machine of small output. This must, of course, be effected in such a manner as to prevent the alternating e.m.f. from sending a current through the auxiliary continuous-current machine. In the case of a three-phase generator with a Δ-coupling of the coils, the armature circuit may be opened at any convenient point, and the dynamo introduced into the circuit at that point. If the coupling of the coils is a star coupling, it may be temporarily converted into a Δ-coupling for the purposes of the test ; or a three-phase transformer may be connected to the alternator, and the dynamo terminals joined to the neutral points of the alternator and transformer (a continuous current being at the same time sent round the secondary of the transformer, arranged Δ fashion). Similar arrangements may be adopted in testing large transformers. If two such transformers are available, the primaries and secondaries are coupled star fashion, the free ends of the secondaries of one transformer being connected to those of the other (the e.m.f.'s being in opposition); two sources of continuous e.m.f. are then used, one being connected between the neutral points of the primaries, the other between those of the secondaries. A. H.

2275. *Interpolar Induction and Distribution of Copper in the Armature of a Siemens Alternator.* **E. Wilson** and **W. Marden.** (Electrician, 47. pp. 633–635, Aug. 16, and pp. 679–681, Aug. 23, 1901.)—Experiments to determine the distribution of induction between the pole-pieces of a Siemens 12-pole alternator are described. The armature was taken out of the machine, and a flat piece of wood, in which exploring coils of various shapes were embedded, was placed opposite a pole-piece. The current in the exciting coils being reversed, the throws on a ballistic galvanometer, put successively in series with the exploring coils, enabled the induction density of the field to be calculated and mapped out. The air space was then altered from ⅛ inch to 1⅛ inch, and the magnetic field again mapped out. From these diagrams the e.m.f.'s generated by loops of wire embracing given fractions of the pitch of the magnet-poles is found, and the e.m.f. waves for the two cases are constructed. The innermost turns of the armature were found to contribute an e.m.f. with two maxima per half period. The figures obtained by calculation agree with those obtained when the machine is running. The leakage coefficients found show the effect of varying the air-gap. The most economical distribution of copper in the armature for a given air space and distribution of induction is considered. The authors do not feel justified in drawing any general conclusions, but in the particular magnetic circuit experimented on, the armature loss is a minimum when the ratio of the width of the armature winding to the pitch is one-third. A. R.

2276. *Large Continuous-Current Generators.* **H. M. Hobart.** (Elektrotechn. Zeitschr. 22. pp. 650–653, Aug. 15, 1901.)—The author compares English and American specifications for large generators with Continental ones. Both require a fixed position of the brushes for all conditions of load, and the differences in other respects are set forth in the following table:—

	English and American.	Continental.
Overload capacity	50 per cent. during two hours without excessive sparking or heating.	25 per cent. during half-hour without excessive sparking or heating.
Maximum temperature rise measured thermometrically	35° C.	50° C.
Temporary overload ...	100 per cent. without excessive sparking or heating.	50 per cent. without excessive sparking or heating.

The author states that a convenient estimate of the sparking tendency is given by the product of the square root of the armature ampere-turns per pole into the reactance voltage. He advocates the use of relatively wide, shallow slots, and of several commutator segments per slot. A temperature rise of not more than 0·7 to 1° C. per watt per square decimeter of the cylindrical surface of the armature is easily obtained with well-ventilated armatures. On account of the uncertainty regarding the correction for the fringe of the field, the author assumes the cross-section of the air-gap to be equal to the polar area, and finds that, for practical purposes, in calculating the ampere-turns, this assumption is sufficient. He advocates an air-gap induction of about 8,700. A tabular comparison of three 1,000-kw. generators is given, one of these being by Siemens and Halske, another by the General Electric Company, and a third designed by the author. A. H.

2277. *No-load Losses in Induction Motors.* **G. Benischke.** (Elektrotechn. Zeitschr. 22. pp. 698–700, Aug. 29, 1901.)—The method employed by the author for separating the various losses at no load depends on the fact that for small loads the slip is proportional to the load. The slip may be measured with great accuracy, even at no load, by the author's stroboscopic method [see Abstract No. 1116 (1899)]. If the power-slip line (power as abscissa, slip as ordinate) be produced backwards, its intersection with the axis of power will give the true power lost by friction. On subtracting this from the wattmeter reading at no load we get the iron loss. The author draws attention to the fact that the observed iron loss considerably exceeds the calculated one, and that the commonly made assumption as to the iron loss in the rotor being negligible when the rotor is running is not borne out by experiment. According to the author's results the iron loss is almost the same in a standing as in a running rotor. This he attributes to high-frequency magnetic fluctuations in the rotor teeth and to the fact that the field is a pulsating as well as a rotating one. He further discusses the discrepancy between the calculated and observed values for the iron loss, and attributes it to the want of uniformity in the flux distribution, and to the magnetic hardening of the core discs under the mechanical treatment through which they pass in the process of construction. A. H.

2278. *Theory of Rotary Field Motors.* **Meller.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 93–137, July 6, 1901.)—A rotary magnetic field similar to that produced by polyphase currents can be obtained by rotating a coil carrying a constant continuous current. From this are deduced all the ordinary formulæ for the starting torque, lag, &c., of asynchronous motors. Asynchronous motors at constant current are first considered, and the effects of armature reaction are clearly explained. A formula is found for the torque, taking magnetic leakage into account, when the motor is supplied at constant voltage. The resultant magnetic flux is then constant, but at constant current it is the total magnetic flux that is constant The use of an asynchronous motor as a frequency converter is fully explained. A. R.

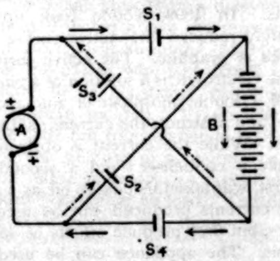
2279. *Self-starting Single-phase Motor without Brushes.* **J. Fischer-Hinnen.** (Elect. World and Engineer, 37. pp. 1066–1067, June 22, 1901.)—This motor consists of two stators arranged coaxially, with the poles set at an angle of 45° with each other, if the machine is bipolar, or generally at an angle of $\frac{90^\circ}{p}$ ($p =$ number of poles). A long armature (which may be of the ordinary short-circuited type, or a wound rotor with slip-rings) rotates within the two stators. The machine is started by switching the current on to one stator only; the current induced thereby in the rotor winding produces in its turn a magnetic field in the other stator, which is in such a direction as to produce a turning moment in the rotor conductors when in this field. The motor then runs up to speed, and when synchronism is reached, the other stator is switched on, and the machine continues to run as an ordinary induction motor. The author points out that the direction of rotation simply depends on which stator is switched on first. It is suggested that the principle could be applied to arc lamps and wattmeter mechanism. The author also shows that the self-starting effect can be obtained by closing the secondary stator field through a short-circuit across two points on a diameter inclined at an angle of $\frac{90^\circ}{p}$ to the magnetic axis of the primary stator field. In either case the slots should be entirely closed. B. P. S.

2280. *Constant Current Transformers.* **R. B. Owens.** (Elect. World and Engineer, 38. pp. 21–22, July 6, 1901. Abstract of a paper read at the Ottawa Convention of the Canadian Electrical Association.)—For street arc-lighting it is advantageous to have a transformer which will give a constant secondary current over a wide range of loads. A test of a small constant-current transformer of the repulsion type is first described. The regulation is excellent, the current remaining constant over a wide range, but the power factor of the whole transformer is low, having a maximum of about 0·8 when the frequency is 60, and a still lower maximum for higher frequencies. The author next describes a method, due originally to Leblanc, of obtaining constant currents by means of choking coils and condensers. A choking coil and a condenser are put in series, and the condenser is shunted by another choking coil and the variable load. When a constant p.d. was applied at the terminals of the two in series, it was found that the current in the circuit shunting the condenser was very approximately constant, this effect being due to resonance. The power factor of the combination was very high, being about 0·99 over the whole range. The author thinks this method might be usefully developed commercially.

A. R.

2281. *Pollak's Electrolytic Rectifier.* **J. Blondin.** (Soc. Int. Élect., Bull. 1. pp. 323–338, July, 1901.)—The author prefaces his paper by a historical sketch, from the first discovery by Buff in 1857 of the electrolytic valve action of an aluminium electrode; its rediscovery by Ducretet; the discovery of analogous phenomena in the case of other metal electrodes, of the electric arc between carbon and metal, and of Crookes tubes; by Nichols, Eichberg and Kallir, and Villari respectively. He then discusses the contributions made in succession by Beetz, Streintz, Hutin and Leblanc, Pollak (whose first patent was taken out in 1895), Graetz, Wilson, Kaller, Norden and Nodon, bringing the development down to Pollak's recent notable advances. The latter, by the substitution of potassium phosphate as the electrolyte, in place of the sulphuric acid previously used, succeeded in raising the maximum p.d. possible between the electrodes, without breaking down the unilateral insulation, from 20 to 140 volts. He then further increased this to 200 volts, by a process to which he gives the name of *formation*. The aluminium plate, about 1 mm. thick, is first immersed in caustic potash solution until the thickness is reduced to about 0·75 mm., all traces of grease and adhering metallic particles being thereby removed. It is then made the anode, with a lead kathode, in a slightly acid solution of potassium phosphate; and the p.d. between the electrodes is gradually increased until it amounts to 200 volts. To prevent destruction of the aluminium plates they must be entirely immersed in the electrolyte, the aluminium must be protected by rubber cushions from any contact other than with the rubber and the electrolyte, and the temperature must not be allowed to rise above 40° C.

In the practical use of these rectifiers, *e.g.*, for charging accumulators from alternate current supply leads, one lead may be connected to the neutral point of the battery while the other is divided into two branches, one being connected to each pole, and each containing a rectifier, the aluminium plate of one being connected to the positive pole of the battery, and the lead plate of the other to the negative pole. In this arrangement, however, only half the battery is being charged at any one moment, and to obviate this Pollak employs 4 rectifiers, S, arranged as shown below, the thick line in the diagram of the rectifier representing the aluminium plate.



With a load such as accumulators or motors, in which there is a counter-e.m.f., only the crests of the waves are utilised : this will also hold good for arc lamps [on account of the unilateral conductivity of the arc] which the author includes among loads giving rise to a counter-e.m.f. The current will therefore be unidirectional, but interrupted. With a load such as incandescent lamps, where there is no counter-e.m.f. [nor unilateral conductivity] the current will be unidirectional and undulatory. In the case of polyphase currents, in which two rectifiers are required for each phase, the current will become more nearly a steady one the greater the number of phases. Illustrations are given of the rectifier as now made by Pollak. By making the depth of electrolyte about three times that of the plates, he has been able to run for four hours without raising the temperature above the limit of 40°. The rectifiers may be kept cool for longer runs by means of a system of tubes with water circulation. Hitherto he has only been able to make them of small sizes owing to the difficulty of preventing buckling of the aluminium plates.

The plates must be removed from the electrolyte when not in use, as otherwise they slowly dissolve. When this precaution is taken they can be run from 500 to 800 hours. It is not found possible to run two rectifiers in series, as the interactions very soon break down the unilateral insulation in one or other of them.

Pollak states that he has obtained an efficiency of from 75 to 80 per cent. with a current density of 1 ampere per square decimetre of aluminium, a voltage of 110 and ∾ 42. The efficiency is found to increase with the p.d. up to the possible limit, and diminishes with increase of frequency.

The rectifiers have been successfully employed with arc lamps, accumulators, and shunt-wound motors, no abnormal heating being observed in the latter case due to the variation of the current. The author ascribes this to the variation being minimised by the fact that the motor itself maintains an exciting current during the intervals of no current from the source of supply. Various practical applications are suggested in the paper. G. W. DE T.

2282. *Electrolytic Rectifiers.* **J. A. Montpellier.** (Électricien, 22. pp. 17–18, July 13, 1901.)—In order to render alternating currents available for direct-current applications, the current must be commuted (1) by commutators, rectifiers, or converters, or (2) by electrolytic "valves." The latter have hitherto fallen short of giving really practical results. The author discusses the various fruitless attempts made to turn this discovery to practical account. In none of the cases, however, was the efficiency above 15 per cent., and the electrodes were rapidly destroyed; much heat was developed, and as many as five cells might be required on a circuit of 100 volts. In 1899, Nodon took up the subject at the Sorbonne, and ultimately reduced the active surface to a minimum, with a large opposed surface of graphite. The active surface is an alloy of zinc and aluminium, and the electrolyte is a solution of a phosphate. During one-half period a pellicle of a double phosphate of zinc and aluminium is formed on the active electrode, and obstructs the current; at the next this is removed and the current passes. While the current is obstructed, the cell takes an electrostatic charge like a condenser; and a second circuit, of different resistance from the first, will take this charge off as a second rectified intermittent current. The currents produced can be used for electrolysis and to charge accumulators, but they produce effects of self-induction, Foucault currents, and hysteresis. The appliance can be used for pressures up to 2,000 volts, and the efficiency is 80 to 95 per cent.; the weight is 4 kg. per kilowatt at 500 volts. The electrodes do not wear away (except the graphite, very slightly), and the electrolyte does not alter. The temperature, however, must not rise above 30° C. A. D.

REFERENCES.

2283. *Alternator Design.* **G. Grassi.** (Elettricità, Milan, 20. pp. 330–333, May 25, and 376–379, June 15, 1901. Paper read before the A.E.I. at Turin, March 2, 1901.)—The paper gives a large number of formulæ for determining the dimensions of the armature of an alternator, and gives expressions for the eddy-currents in iron and copper. G. H. B.

2284. *Leakage Flux of Three-phase Winding.* **J. L. la Cour.** (Elektrotechn. Zeitschr. 22. pp. 553–554, July 4, 1901.)—A letter criticising Niethammer's method [see Abstract No. 1808 (1901)] of calculating the leakage flux, and suggesting certain corrections. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2285. *Long-Distance Power Transmission.* **F. A. C. Perrine.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 501–509, June and July, 1901.)—A clear statement is given of the main difficulties to be overcome in designing long-distance power transmission schemes. When the voltage rises above 30,000, the problem of suitable insulators is an exceedingly difficult one. The insulators, which are of glass or porcelain, must have a diameter of at least 12 or 18 inches, and be held about 8 inches above the cross-arm. It is difficult to make them of sufficient mechanical strength. Also the energy losses due to brush discharges makes the use of wire less than ⅜ inch in diameter prohibitive. The lines have to be constantly patrolled, and a right-of-way almost as wide as a railroad secured. Unless the capacity current is neutralised by reactance coils, the transmission at light loads is commercially impracticable. Oscillograph pictures of actual current waves show ripples due to the armature slots in the generator. A synchronous motor with a bad wave form took "full load" current at no load. The difficulty was remedied by putting a reactance coil in parallel with the lines. A. R.

2286. *Storage Batteries in Electric Power Stations, Controlled by Reversible Boosters.* **J. S. Highfield.** (Inst. Elect. Engin., Journ. 30. pp. 1040–1074; Discussion, pp. 1075–1096, Aug., 1901.)—This paper is written with the object of showing the chief points to be considered in the design of batteries for central station work, and to describe subsidiary apparatus for use with batteries. It is stated that it has generally been the practice to instal a battery, having a capacity (reckoned at the three-hour rate of discharge) of but a small proportion of the whole station plant. As the load increases year by year, this battery usually comes in for a good deal of ill-treatment, and is soon irreparably damaged. The use of regulating cells with batteries involves the adoption of costly switches and connections, while at the same time these cells depreciate more rapidly than the others owing to difficulties of charging, &c. To obviate the disadvantages of regulating cells, the author has used a variable pressure booster, which is described. By regulating the station pressure by the booster and battery, the generators may be run at full load almost automatically, provided always that the battery is of proper capacity. The battery serves three purposes: (1) To control the station pressure; (2) to carry the peak and allow of the generators being run fully loaded; (3) to carry the whole load when within its capacity. In lighting stations, the battery steadies the pressure considerably when large motors on the mains are started up, and is a source of security when faults are burnt out on the system, saving the generators and minimising the fall in pressure. Curves of cost per kw. of batteries complete with reversible booster, for varying rates of discharge, are given, and assuming £35 per kw. as an average figure for cost of steam and electric plant, it is stated that the battery costs for a three-hour rate of discharge will be the same, decreasing as the size of the battery increases. For the rate of discharge mentioned, the battery, in a lighting station, should have a capacity of at least one-fourth to one-sixth of the maximum load on the station. It will then safely carry the peak for three hours. The battery losses are amply compensated for by the better load factors of the engines and steam-raising plant, besides which a shift of men may be often saved. The author advocates the adoption of steam units of a uniform size, and a battery of the capacity of a steam set for three hours, being about one-eighth of the capacity of the station ultimately. The battery capacity may be less in large stations. The nature of the all-night load also determines the ratios. The measured efficiency of a battery, from July to December, is given as 74 per cent. The author believes in charging at a greater current than the makers specify, at commencement, and finishing at quite a small current. The convenience of the battery when repairs have to be done to steam plant is alluded to; also the saving of copper in feeders by installing batteries in substations. For traction stations, the batteries may discharge at the one-hour rate normally, and the cost be taken at this rate, which will give £15 to £18 per kw. Curves are given, illustrating variation of voltage on charge and discharge at various rates, also on sudden variation of the load. An ideal arrangement of working is mentioned, and a special booster described which will enable this arrangement to be approximated to. Curves showing the results of the working of this machine are appended, and for the month of March various percentages proving the efficacy of the system. It is stated that the ultimate object of the booster is to correct for the varying characteristic of the battery, which is here discussed. The fluctuations of the current taken by the booster motor are considered, and it is mentioned that the booster brushes work without lead and do not spark with a current of 200 amperes when there is no field. In the case of tramways operating 400 cars and upwards, the battery would only be useful in the central station for carrying night loads, &c., but separate batteries in substations would enable each route to be worked as a small system, saving copper in the feeders and obviating the necessity of rail-boosting. The same arguments apply to loads on converters fed from a high-tension transmission system. On a *railway* system the substations ought to be near the load centres. In a combined station the batteries should be interchangeable to either load. Shunt-wound generators may be used all round. Cost of battery depreciation is stated to be 7 per cent. per annum. A curve showing the connection between running costs and plant load factor is given. The increased efficiency of the battery on intermittent loads (over 81·4 per cent.) appears to arise from the fact that the pressure due to the gas effect is utilised on short discharges. In the appendix the units of a combined station are tabulated, and a second table shows the ratio of battery to steam plant in some direct-current stations. In the discussion which followed some references were made to the previous use of boosters for the same purpose.

B. P. S.

2287. *Pressure Regulation in Distributing Networks.* **E. Vollhardt.** (Zeitschr. Elektrotechn., Wien, 19. pp. 330–332, July 7, and pp. 341–348, July 14, 1901.)—It is usual, in calculating the pressure drop along a distributor, to assume that the two feeding-points which it connects are maintained at the same p.d. The calculation is generally carried out on the assumption that all the current-consuming devices are in circuit simultaneously. But if one portion of the distributing network should happen to be heavily loaded at a time when the remainder is lightly loaded, the p.d. at the various feeding-points will no longer be the same, and a much greater drop of pressure may occur along a distributor than that calculated on the assumption of equality of p.d.

at its two ends. The practical remedy is to connect the feeding-points by means of an extra *equalising* main. The author gives an account of the theory of such equalising mains developed by Teichmüller [see Reference No. 1457 (1901)], giving formulæ for calculating their size in order to maintain the pressure drop within prescribed limits. A. H.

2288. *Refuse Destructors and Electric Light Stations.* **J. S. Highfield.** (Electrician, 47. pp. 606–607; Discussion, pp. 607–609, Aug. 9, 1901. Paper read before the Municipal Electrical Association at Glasgow, June 21, 1901.) —The author draws attention to some points in connection with the design of such stations, and gives figures showing the results of working at St. Helens.

FIGURES FOR ONE YEAR'S WORKING OF A TWO-FURNACE REFUSE DESTRUCTOR.

	Total for year.	Average per week.
Weight of refuse burnt	9,778 tons	188 tons.
Electric energy used to drive fan and other motors	70,000 units	1,346 units
Units generated by steam	365,000 „	7,019 „
Wages on burning	£750	£14 8s. 6d.
Wages on repairs	£86	£1 13s. 1d.
Total wages	£836	£16 1s. 7d.
Weight of clinker produced	3,900 tons	75 tons.
Value of mortar sold	£221 9s. 8d.	£4 5s. 2d.
Value of electric units generated at 0·3d. per unit generated	£450	£6 13s. 1d.

Averages per ton of Refuse Burnt.

Units generated	37·8
Units used on works	7·1
Cost of burning (including wages, light and power)	22·1d.
Cost of repairs (wages and stores)	3d.
Total cost of destruction	25·1d.
Cost of removing clinker not otherwise used	5·5d.
Total cost of destroying refuse and removing part clinker	30·6d.

These figures do not include the cost of carting the refuse, which is stated to be 2s. 6½d. per ton. [See also Abstracts Nos. 1797 (1899) and 2330 (1900).]
W. H. S.

2289. *Capacity Currents Influenced by Frequency.* **T. Mather.** (Elect. Rev. 48. pp. 915–917, 1901.)—The author noticed that increase of speed of an alternator was sometimes accompanied by a diminution of the condenser current in the cable, whereas the opposite would have been expected. To explain this he made experiments on ten paraffin paper condensers having 50 mfds. capacity, with an alternator giving a wave, the shape of which showed a very large third harmonic in anti-phase. The p.d. on the condenser was kept constant, and the power taken by it for different frequencies noted and plotted as a curve. The character of these curves shows that the capacity current is abnormally high with the peaky wave. It was found that at a frequency of 28 and 118 respectively the condenser currents did not differ much from the normal values given by the formula—

$$\text{Microfarads} \times \text{R.M.S. voltage} \times 2\pi \times \text{frequency} \times 10^{-6},$$

but at a frequency of 81 the current is 6·15 amperes instead of 2·8, the former being 2·68 times the latter. Well-defined maxima of current appear at frequencies of 49 and 37. The frequencies at which these maxima occur are in the ratios $\frac{1}{3}:\frac{1}{4\cdot95}:\frac{1}{6\cdot57}:\frac{1}{8\cdot54}$ thus naturally suggesting that they were due to the third, fifth, seventh, and ninth harmonics in the e.m.f. wave of the machine. The self-induction h of the machine measured in henries is given by the resonance formula $hFp^2=1$, where $F=$ capacity in farads $=\frac{49\cdot4}{10^6}$ and $p=2\pi$ times the frequency of the harmonic considered. The magnitudes of the maxima of a current are proportional to the magnitudes of the harmonics, and this suggests a method of analysing alternator curves by the aid of a current-frequency curve. Special attention is called to the dangers to which cables are exposed from the possibilities of resonance effects with the higher harmonics, although the capacity may be too small to produce resonance at the normal frequency. For the capacity required to produce resonance is inversely as the square of the frequency, *e.g.*, the fifth harmonic will resonate with 1/25th of the capacity required by the fundamental. It is to be noted that a resonating component sends a current through the system, depending only on the ohmic resistance of the system and on the magnitude and frequency of the component, so that currents and p.d.'s on the cable may become large quite unexpectedly through small changes of speed, or through change of inductance or capacity caused by the switching on or off of transformers or cables. M. O'G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2290. *New Transformer Station of the Niagara Cataract Power and Conduit Company.* **F. P. Woodbury.** (Amer. Electn. 13. pp. 385–388, Aug., 1901.)—The station receives about 14,000 kw. by three-phase transmission from the power-house at Niagara Falls, at an e.m.f. of 22,000 volts, and delivers it 11,000 volts three-phase to the underground system of the City of Buffalo. The three transmission lines, of three conductors each, after entering the building (Wurtz lightning arresters being connected close to the point of entry) pass to the circuit-breakers at the top of the switchboard panels. Below each circuit-breaker is a selector switch for delivering the current to either of the two batteries of transformers—each battery consisting of three transformers (each of 2,250 kw. capacity), with an additional one in case of emergency. The construction of these switches is shown; they are specially designed to avoid the accidental closing of a circuit, and are operated by means of a hook at the end of a long wooden pole. Static interrupters are interposed between the high-tension bus-bars and the transformers. These consist of a choking coil in the main circuit, with a condenser, of which one pole is connected to the main between the choking coil and the transformer, while the other pole is earthed through a fuse. On the secondary switchboard (which is of similar design to the primary) the current is brought to bus-bars through selector switches; the terminals of these are earthed through a condenser and fault detector. From the secondary bus-bars the current passes through feeder switches, series transformers (the secondaries of which are connected with ammeters and recording wattmeters), and current-breakers (which are fixed in a separate gallery) to the outside circuits. The pressure of the secondary circuits is indicated by two voltmeters, connected with the secondaries of transformers, of ratio 12,000 to 100; these also feed the shunt circuits of the two recording wattmeters. All the instruments are on the secondary board.

The circuit-breakers for the feeder circuits are fitted with a clockwork mechanism, which will only allow the circuit to be opened if the overload continues for a predetermined time, for which the relay is set.

The circuit-breakers on the primary circuit are similar to those on the secondaries, but are, in addition, provided with reverse current relays. These are constructed like a wattmeter, the shunt coil being excited from an outside, but constant source. The series coil is in series with the secondary of a series transformer whose primary is in the line. Should power be forced backward through the circuit-breaker from some other line, owing to a short circuit on one of the parallel lines, the reverse current relay will connect a battery to the time-limit relay, and if the reversal of power continues beyond the period of time-limit, the circuit-breaker will be opened through the time-limit relay, as in the case of an ordinary overload. The plant is of Westinghouse design and construction.

The paper is illustrated by photo blocks and diagrams of connections.

B. P. S.

2291. *Hagneck Electricity Works.* **H. Rupp.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 937–947, July 6, 1901.)—The works, which are near Aarberg, in Switzerland, are fully described with the help of twenty-two plans and photographs. There are five double turbines with vertical shafts by Bell & Co., each of 1,300 h.p. They are directly coupled to three-phase "umbrella" type generators designed for 8,000 volts at 40 ∿, and are excited by four-pole machines at 120 volts. The electrical plant is by Brown, Boveri & Co. The distribution is by the usual overhead system to transformer chambers. Light and power are supplied at the following prices :—

LIGHTING.

Price of one lamp in francs per annum.

Number of Burning Hours.	Normal Candle-Power.			
	10	16	25	32
Over 1,000	13·5	21	33	42
400 to 1,000............	10·5	16	25	32
Under 400	7	10·5	16·5	21

POWER.

Demand in h.p.	1/10	1	10	100
Price in francs per h.p. per annum ...	270	210	185	145

W. W. H. G.

2292. *Bex-Gryon-Villars Electrical Works.* **K. A. Breüer.** (Génie Civil, 39. pp. 238–239, Aug. 10; and pp. 249–254, Aug. 17, 1901.)—This paper contains a full description, illustrated by thirty-two figures and two plates. Bex is a health resort on the Avançon, a tributary of the Rhone in Western Switzerland. The Avançon is fed by mountain streams and furnishes abundant water-power. Six Escher-Wyss turbines with horizontal axes each give 400 h.p. at 600 r.p.m., and are directly coupled to the generators. Four are Westinghouse three-phase machines for 5,000 volts at 50 ∿. The other two are direct-current dynamos of the Thury type, with six poles, and give 300 amperes and 650 volts. Exciting current for the alternators is furnished by small dynamos of the Manchester type, driven by extensions of the main shafts of the turbines.

All the lighting is obtained from one of the phases, the alternators being so wound that the full power of the turbines can be carried either by one or by the three phases. The distribution is by overhead lines which include: (1) A line of three wires, 7·75 km. in length, supplying a chemical works at Monthey and a transformer at Bex. (2) A single-phase line supplying the substations at Châtel, Lavey-Village, and Lavey-les-Bains. (3) A single-phase line for lighting Posses. The sale of energy is by a special tariff without meters. An important part of the undertaking is an electric railway of 12·5 km., of which 4·9 km. is a rack of the Abt type. The trolley line is fed at 600 volts from the Thury machines. Descriptions of the motor cars and electric locomotives are given. The electrical equipment is by the Compagnie de l'Industrie Électrique at Geneva. The regulating resistances are prevented from overheating (especially during the descents) by using a small electrically driven fan. W. W. H. G.

2293. *Hoylake and West Kirby Electricity Works.* (Elect. Engin. 28. pp. 222–227, Aug. 16, 1901.)—This station has an engine-room 50 ft. by 33 ft., a boiler-house 50 ft. by 48 ft., a battery-room 29 ft. 6 in. by 16 ft., and a pump-room 25 ft. by 14 ft. The chimney has an internal diameter of 7 ft., and a height of 125 ft. There are three Lancashire boilers 28 ft. by 7 ft. 6 in. with superheaters, and an economiser of 192 tubes. There are three 75-kw. steam alternators; running non-condensing, they take 32 lbs. of steam per kw.-hour at full load. There is also a motor-generator for receiving alternate and delivering continuous current, and *vice versâ*. The continuous current is used for charging a battery, which in its turn drives the motor-generator set when the steam plant is shut down. The battery has 120 cells, giving 100 amperes for five hours. Two feeders have areas of 0·1 and 0·15 square inch, and the distributors have either 0·15 or 0·1 square inch section. The article contains several drawings showing arrangements of the power-house, and connections and details of the switchboards. W. H. S.

2294. *Milan-Gallarate-Porte Ceresio Railway.* (Street Rly. Journ. 18. pp. 99–106, Aug., 1901.)—The steam railway between the above points has been converted to an electrical system, the current being conveyed by a third rail. The power-station is situated at Tornavento, which is on the River Ticino, and at a distance of about six miles from the line. At Tornavento it is intended later on to utilise water-power; but at present the machinery is driven by steam. There are three 750-kw. polyphase generators coupled to Corliss engines; the power is distributed through rotary converters. The article contains drawings of the insulators for the third rail and for the overhead transmission lines, and also of the connections on the various switchboards. W. H. S.

2295. *Water-Power Installation at Poses-sur-Seine.* **E. Bret.** (Génie Civil, 39. pp. 265–270, Aug. 24, 1901.)—A description of the way in which the available head of water (about 0·8 meters at the minimum) is utilised at Poses-sur-Seine for working a lock on a navigable arm of the river which joins the Seine at this place, and also for working the sluices of a dam across the main river. The turbine which works the dynamos is of the Fontaine type, developing a maximum of 30 h.p. under the best conditions, but never falling below 12 h.p. A vertical shaft with bevel gearing transmits the power of the generators, increasing the speed at the same time from 25 to 900 r.p.m. The two dynamos, one of which is a standby, are of the vertical Gramme type, shunt wound, each capable of giving 40 amperes at 275 volts. The speed of the turbine is regulated either by hand or automatically by means of a small series dynamo. This is effected through a vertical shaft by means of which the angle of the vanes can be altered. The switchboards are arranged so as to allow the dynamo current to be switched on to a battery of accumulators, or on to the distributing mains, or both together. They are provided with current interrupters, fuses, lightning protectors, fault indicators, and volt and ampere meters. They also include pressure regulators (both hand-worked and automatic) a current reverser as an adjunct to the latter—the object of which is to reverse the current at the field of the motor which controls the turbine in case of the variations becoming excessive—and an automatic arrangement by which cells are thrown in to raise the pressure in case of the e.m.f. of the dynamo falling too low. The battery consists of two groups of cells of the Jacquet type, each group having 54 cells, and each cell having 11 plates with a weight of 34 kg. The cells are mounted on oil insulators. They can be charged in series of 48 cells, and discharged, either with the whole of the cells in series, on the motor circuits, or with the two halves of the battery divided, on the lighting circuits, which are arranged on the three-wire system. In the latter case the number of cells employed in each group is reduced, as the lamps are run at 110 volts. The total candle-power of the lamps installed, which are all used for lighting the locks, or the dam, or different parts of the works, is about 1,000.

The large dam, over 200 metres in length, and with a fall at times of over 4 metres, is of the Caméré type, and the movable sluices are worked by three motors, two of 3 h.p., and one of 7 h.p. Of the three existing locks, the largest only is electrically worked. The lock-gates, of which those at the upper end of the lock are 7·2 metres high and those at the lower end 8·85 metres, both being nearly 7 metres wide, and also the sluices, are operated through bevel gearing and racks and pinions by a single motor of 3,250 watts capacity, from which the power can be transmitted for either purpose by two sets of friction gearing—a method which has been adopted as giving the necessary flexibility of working. The current taken by the motor is found to be from 3½ to 4 amperes at 274 volts during the raising of a sluice, and about 2½ amperes while it is being lowered ; from 5 to 6½ amperes are taken during the opening, and from 3 to 3½ during the closing, of the lock-gates. Four windlasses are erected at the sides of the lock, each worked by a 7 h.p. motor placed in an underground chamber alongside the windlass, which is driven by a worm gearing. A 2-h.p. motor drives a few machine tools in the repairing shop, and one of 4 h.p. has been installed to drive a rotary pump in connection with an establishment for pisciculture. Statistics are given showing the saving in time and labour which has been effected by the adoption of electricity in the working of the lock-gates and sluices, with an analysis of the cost of the whole installation. The paper is well illustrated with photograph, diagrams of connections and detail drawings of the machinery and gearing. B. P. S.

2296. *Toledo and Monroe Railway.* **W. S. Conant.** (Street Rly. Journ. 18. pp. 84–90, Aug. 1901.)—An interurban electric railway, about 20 miles long, is here described. A 400-kw. alternator is installed, and distributes power through rotary converters. Two good drawings of the power-house are given. (See also Elect. Rev. N.Y. 39. pp. 246–250, Aug. 31, 1901.) W. H. S.

2297. *Naples-Aversa-Caivano Electric Railway.* **C. Pio.** (Street Rly. Journ. 18. pp. 79–82, Aug., 1901.)—General particulars are given about two short electric lines, each about 15 miles long, connecting Naples with Aversa and Caivano. The power-house contains four 225-kw. units; two of these are direct-current and two are alternate-current generators. Synchronous motor-generators are installed in substations. W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

2298. *Tramway Track Construction.* **W. Howard-Smith.** (Elect. Engin. 28. pp. 91–94, July 19; 129–131, July 26; and pp. 194–197 (with Discussion), Aug. 9, 1901. Paper read before the Association of Municipal Engineers at Leicester.)—This paper contains much useful information connected with the question of track construction. With regard to rails, a weight, of about 95 lbs. per yard is perhaps the most usual and the best. The author urges the importance of having a standard rail, and gives a drawing of one which might be adopted, having been largely used lately by the British Electric Traction Company. Of late, grooves have been somewhat widened, the Board of Trade having approved some which were 1$\frac{1}{4}$ inches in depth and width. For curves of from 75 feet to 50 feet radius, this groove should be sufficient, and curves of smaller radius should never be employed. Wheels of 30-inch diameter on a 6 ft. 6 in. rigid wheel base, with $\frac{3}{4}$-inch flange, running in a 1$\frac{1}{16}$-inch rail groove, commence to bind against both sides of the groove at 66 feet radius. Vignoles rails should be used in the car-sheds, having detachable guards bolted on, if necessary; in this way sharper curves are possible. The author is of opinion that 45-feet rails are probably the best on the whole; in any case, the question of expansion is of no importance, owing to the small area of rail surface which is exposed, and the number of joints should not affect the question on a well-constructed track. The design of turn-outs is fully dealt with, and a drawing is given, accompanied by a table showing the various dimensions for diamond turn-outs with various angles of crossing. The author has found 1 in 5$\frac{1}{4}$ to be a good angle for town lines, while he prefers 1 in 7 for suburban lines, working at higher speeds. Concrete composed of 6 of aggregate to 1 of cement under the rails is recommended, and of 8 to 1 under the paving, the depth being 6 inches below the rail, and 4 inches to 6 inches below the paving. The best method of laying the concrete is to first lay the rails to their proper aligment and level, temporarily supporting them at intervals; the concrete is then to be thrown in to the right level, men being told off with strong spades to make it solid under the rail base. The life of rails with electric traction is not yet properly ascertained, but the author thinks that where the frequency of service is five minutes or less, and the traffic heavy, rails should last 8 to 12 years on straight lines, with gradients less than 1 in 40; for 6 to 10 years for steeper gradients; and for 2 to 6 years on curves having radii less than 66 feet. Fishplates are now generally supplemented by some form of soleplate; the rigidity of the joints is a matter of the first importance, the life of the joints being practically the life of the track. The author gives a detailed estimate of the cost of construction of track; for a 3 ft. 6 in. gauge, this amounts to £5,096 per mile of single track. A long table is also given, showing analytical particulars of some of the most recent sections of girder rails used in this country. The original paper should be consulted for information on rails, rail lengths, rail joints, springing of rails, bolt-holes, fishplates, tiebars, curves, points, turn-outs, concrete foundations, wheel tyres, &c. W. H. S.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

2299. *Mixed Trolley and Conduit Systems.* **A. N. Connett.** (Inst. Mech. Engin., Proc., 2. pp. 375-396; Discussion, pp. 397-425, Feb.-May, 1901.)—From a working point of view the author prefers a centre slot to a side slot. In the latter there is difficulty with the switches; the plough or conduit receives more mud or water on account of the wheels; and the slot rail, being also the wheel rail, requires a vertical web which renders inspection more difficult. But owing to the elimination of the band of iron in the centre of the track the side slot is sometimes specified by municipal authorities.

In practice the switches are responsible for most of the interruptions in service, and therefore arrangements must be made so that the switching is effective; or, if it fails, so that the plough automatically disengages itself. In the case of a side slot, it is better to deflect the slot to the centre just before the car switch is reached.

In a mixed line it is necessary to have a plough which can be withdrawn at the end of the conduit. Ploughs may be made with "flappers" so that they can be withdrawn though a 1¼-inch slot without any additional opening, but the construction is cramped, and therefore unsatisfactory. The best form of plough is one having soft cast-iron shoes pressed lightly against the vertical faces of the conductor bars by semi-elliptic springs placed horizontally. With regard to distribution, the conduit should have a separate circuit, which may be supplied by a separate dynamo, or by a motor generator suitably placed. It has been found that conductor bars of mild steel, connected by two bonds at each joint, have a carrying capacity of about one-eleventh of copper bars of the same cross section. The carrying capacity may be increased by attaching to them bare copper cables. The author gives an account of the mixed system which he laid down in Paris [see Abstract No. 766 (1900)].

The cost of a side slot is about £500 per mile less than the centre slot. There is also an economy in frogs unless the slot is deflected to the centre, when the cost is greater. Under ordinary conditions, including the cost of special track work and the removal of underground obstructions, the additional cost of a conduit over a trolley system will vary between £7,000 and £9,000 per mile of single track. The author gives details of cost for the Metropolitan Railway of Washington (£9,946 per mile of single track), some details of cost of the Second Avenue Railway of New York, and an estimate of cost for England (£16,484 per mile of single track).

Discussion.—**E. K. Scott** suggested certain modifications and gave sections of the conduit at New York and Paris, and of the Westinghouse Company. **R. T. Smith** stated that there was no difficulty in cleansing a conduit like that at Brixton for £60 per mile [per annum], and suggested that it might be worth while to have a shallower conduit on account of obstruction and to pay more for cleaning. **J. E. Waller** was in favour of a flexible conductor, and objected to the side slot. He thought that the cost of conduit construction as given by the author was put at too high a figure, and gave estimates showing that the additional cost of the centre conduit as compared with the trolley was £5,461 per mile of *double* track, which would reduce to £4,437 for side slot, excluding special track work, temporary track, obstructions and feeder-ducts. The **Author,** in reply, mentioned that a central slot of ¾ inch should be gauged in construction to ⅞ inch, owing to the tendency to close. Trouble had been caused by ploughs breaking down in insulation. In Paris it had been found advisable to use a double set of ploughs, changing them each night, so that they might be dried after each day's run. As to cost of running; at Brussels the conduit cost 1¼ farthings more per car-mile than the trolley system; including the fixed and amortisation charges this came to 2·9 farthings per car-mile. In Washington the cost of cleaning conduits amounted to £5 10s. per annum per mile of single track. The author was of opinion that a depth of conduit of 8 to 10 inches was necessary below the conductor rails. He did not believe that it was necessary to have the running rails carried by the yoke in centre slot construction. Flexible conductors would only increase the cost. He did not think that the conduit for which J. E. Waller had estimated would be strong enough. W. R. C.

2300. *Electric* v. *Steam Traction on Railways.* **E. Cserhati.** (Écl. Électr. 28. pp. 130–140, July 27, 1901.)—The author considers the problem from the point of view of running costs, assuming that three-phase motors are used. The economy in fuel should be considerable, for the best compound locomotives require 8 kg. of steam per h.p.-hour measured at the tread of the wheel, which figure may increase greatly with unfavourable conditions of working, whereas, allowing for inefficiencies in transmission and transformation, an electrical h.p.-hour measured in the same way can be obtained under almost all the varying conditions found in practice for 8 to 9 kg. of steam at the power station. In most steam locomotives used for slow service, the steam consumption is about 50 per cent. greater. Apart from the question of steam consumption, there is much greater efficiency in a stationary boiler than in a locomotive boiler, and standby losses are much reduced, so that there is a considerable saving in coal by the use of a power station.

The suppression of the tender alone means 20 to 50 per cent. less weight in the locomotive. The weight may be still further reduced, for although the proportion of weight used in tractive effort does not exceed 16 per cent. in the case of steam locomotives, this figure rises to 25 or 30 per cent. for electric locomotives, as shown on the Baltimore-Ohio line. Since the turning moment of the motor does not vary as the latter rotates, a greater tractive effort can be obtained for a given weight than with steam; also the coefficient of friction seems to be increased by the passage of the current from the wheel to the rail. The friction of the working parts is also less. Actual results show that the weight per unit of tractive effort is 100–110 kg. for steam locomotives, whereas it is only 66 kg. for electric locomotives, and 38 kg. for railway motor cars.

Among other advantages of electric traction may be mentioned the return of energy to the line by three-phase motors instead of loss by braking, lower maintenance charges on fixed boilers, and on motors as compared with exposed steam mechanism, less deterioration of rolling stock generally and permanent way, reduction in staff, and easier handling of traffic. W. R. C.

2301. *Storage Batteries in Traction Systems.* **G. A. Grindle.** (Inst. Elect. Engin. Journ. 30. pp. 1098–1127, Aug., 1901.)—The author refers to the adoption of storage batteries for vehicles carrying their own sources of power, and to early attempts at transmitting power through a third rail, or overhead conductor, but the main object of the paper is to deal with the function of the secondary battery as a governor in an electric traction system, whereby it maintains a steady and economical load on the generators.

The necessity for a battery and the advantages to be obtained from it are discussed, and the question of cost entered into, showing a saving in operating plant. This result is arrived at by assuming £30 per kw. as the cost of steam plant, and £12 per kw. for battery plant (including booster, &c.); the relative working lives of both plants, however, and also the cost of upkeep in both cases, being left out of account. It is pointed out, however, that less spare plant is required when the battery is adopted.

The case of batteries in substations is considered, with the conclusion that large savings may be made in feeders on account of the copper only being required to carry the normal generator load. The saving to be made in cost of operation is obvious, as the engine load factor is always high, and the reduction in coal consumption on this account is given as 75 per cent. The battery losses are given for an actual case and are very low, the efficiency of units used to those generated being 91 per cent.

The author indicates what the relative proportion of the battery to station capacity ought to be, and then shows how the battery ought to be employed, whether in the power station or a substation. The cases of regulating either by cells, an ordinary booster, or a differential booster, are then examined, and the opinion is expressed that the last is the proper way to work. It is stated that the working conditions under the last system are most favourable to the life of the battery. Diagrams of load variation are given, showing the steadiness of the generator load when the differential booster is used.

Plates of the Planté type are recommended, owing to the small resistance of the cells, and their capability of standing high rates of charging. So far the reversible booster, as arranged by J. S. Highfield, is said to be the best. The author concludes that the battery should be the real regulator of the system, and that the engines should run at constant steam admission and pressure. B. P. S.

2302. *Electrolysis by Earth Returns.* (Eng. Record, 43. p. 545, June 8, 1901. Extracts from Prof. **Caldwell's** Report on Electrolysis Survey at Columbus, Ohio.)—Caldwell made numerous measurements of the volts between the tramway rails and water-pipes, and of the currents in the pipes. A table of the results is given, showing currents up to 8 amperes in certain pipes. The difference of potential between rails and pipes was much greater where the bonding was imperfect. The recommendations made are as follows: (1) Bonding must be maintained in good condition. (2) The drop of potential in the rails must be kept small by numerous insulated return feeders. (3) There should be no earth at the power station. (4) The rails should be laid in concrete or other poor conductor. (5) There should be no connections between the rail and water-pipes.

As regards the water-pipes, the recommendations are: they should be laid as far as possible in side-streets; the bells should be laid towards the direction in which the current will flow, so that electrolysis, if any occur, will be at the ends of the bells, where it would be least injurious; in making joints, the coating on the pipes should be kept intact, and the pipe, for six inches on either side of the joint, should be given a coating of asphalt. G. H. B.

2303. *Electrolysis by Earth Returns at Peoria, U.S.A.* (Street Rly. Journ. 18. pp. 65–69, July, 1901).—This is the report of the Master in Chancery on the case of the Peoria Water Company *v.* the Central Railway Company for an injunction to stop the latter from damaging the water-pipes of the former company by electrolysis [see Abstracts Nos. 581 (1901) and 2518 (1900)]. The report shows that damage has been done, and that electrolytic deposits have been found. Potential differences between the pipes and rails have been observed up to 45 volts. This upper limit was reduced to 35 volts in 1899, but, needless to say, the injury still continues. Since the evil can be remedied by the double trolley, the Master's conclusion is that the injunction should be granted. W. R. C.

2304. *Effects of Poor Rail-bonding.* (Eng. Record, 43. pp. 601–602, June 22, 1901.)—Two cases are described where the bonding of tramway rails had so deteriorated that differences of pressure, amounting to 10 volts, were set up between the rails and neighbouring water-pipes. Full details are given, with diagrams. G. H. B.

2305. *Starting Resistances for Car-motors.* **M. Kubierschky.** (Ind. Élect. 10. pp. 372–373, Aug., 1901.)—The author refers to a paper by Bunet [see Abstract No. 1897 (1901)], in which a formula was given to determine the values of the resistances in the successive steps of a rheostat, in order to insure that the variations of current when starting a car-motor should not exceed certain fixed limits.

The author points out that the results given in that paper are unreliable owing to the writer having neglected, as unimportant, the variations in the magnetic flux in the motor produced by variations of the line current; and he shows graphically by means of curves—the actual characteristic of the motor used by Bunet, and the curves of effort and speed—that the variation of magnetic flux must be taken into account. Taking a concrete example, it is shown that a car of eight tons weight, which would require, according to Bunet's calculations, six steps in the rheostat to start it, with a variation of current of 50 to 70 amperes, would, with the above permissible variation of current, actually require no more than three steps to bring it up to speed. B. P. S.

2306. *High-Speed Electric Railways.* **L. v. Reymond-Schiller.** (Zeitschr. Elektrotechn., Wien, 19. pp. 206–210, April 28; 317–321, June 30; 380–382, Aug. 4; 388–391, Aug. 11; and pp. 400–406, Aug. 18, 1901.)—The author considers the scheme of Zipernowsky, proposed in 1891, for an electrical way between Vienna and Budapest at 250 km. an hour. He then discusses the general question of high speed electrical railways, and classifies the various systems proposed, with special reference to those of Langen and Behr. He introduces for consideration an extensive scheme for a "Central-European-Electrical-Continental Railway," to include a network from east to west, the following being the routes, which are shown on a map:—(1) Budapest—Raab—Pressburg—Vienna. (2) Vienna—Prague—Dresden—Berlin. (3) Berlin—Magdeburg—Hanover—Cologne—Namur—St. Quentin—Paris. (4) Vienna—Munich—Carlsruhe—Strassburg—Mulhausen—Belfort—Chalindrey—Paris. (5) Chalindrey—Chalons—Lyons—Valence—Avignon—Marseilles. The author next considers the question of the width of track necessary for a speed of 250 km. an hour. Examination of the accepted data, and the application of

Hoffmann's formula, prove that a wide gauge is necessary so as to keep the tractive effort small; and it is finally shown that a gauge as wide as 4·5 m. should be used. W. W. H. G.

2307. *Electric Traction on the Bologna-San Felice Railway.* **D. Civita.** (Elettricità, Milan, 20. pp. 409–411, June 29, and pp. 421–424, July 6, 1901.)—The Bologna-San Felice Railway is 42½ kilometres in length, and is worked by accumulator motor cars. Details of the electrical equipment were given in Abstract No. 1208 (1901). The present paper contains an account of some experimental runs, with full details and curves. The following table is a summary of the results:—

Total distance run, km.	84·960
Weight of motor-car, tons	46·046
„ trailer „	7·930

	Out.	Return.	Total.
Ton-km. run (out and return)	—	—	42″7
Time of run, excluding stops	79′·26″	83′·59″	163′·25″
„ current supply	50′·30″	60′·30″	111′·00″
„ starting, total	427″	480″	908″
„ „ mean	35·5″	37·0″	36·24″
Watt-hours consumed in running	19,548	22,570	42,118
„ „ starting	3,787	5,163	8,950
„ „ total	23,335	27,733	51,068
Watt-hours, per km.	550	650	600
„ „ ton-km.	11·1	13·2	12·15
Mean speed, km. per hour	32	30·3	31·15

Sixteen kilometres of the line are on gradients of from 0·48 to 0·5 per cent. A battery which had run 10,580 kilometres was examined, and found in perfect condition. G. H. B.

2308. *Electrically-driven Submarine Boat.* **E. P. Weber.** (Centralblatt für Accumulatoren, 2. pp. 146–148, 1901.)—This vessel was built in 1898, and was put through its trials in 1899. The total length with screw is 17 m., and greatest diameter 2·5 m. Steering is effected by one vertical and two horizontal rudders. The screw is connected through a leather coupling with a 30 h.p. motor, supplied with current from a 490-volt battery of accumulators, giving 720 ampere-hours on a 12-hour discharge. There is no room for a charging plant on board. The speed of the screw is normally 450, but can be halved by switching the two halves of the battery into parallel, and can be raised to 485 by weakening the motor field. Reversal is effected by reversal of the field. The starting resistance is of sufficient section to allow of its use as an additional speed-regulator. The depth of immersion is regulated by water-tanks, which can be emptied by compressed air. It has been found that the boat is too small and that the electric pressure is too high, causing excessive leakage from the battery in its damp and confined position. However, continuous trials of several hours' duration were carried out with closed hatches in rough weather. In the construction of such vessels the writer recommends a closer co-operation between electrician and shipbuilder.

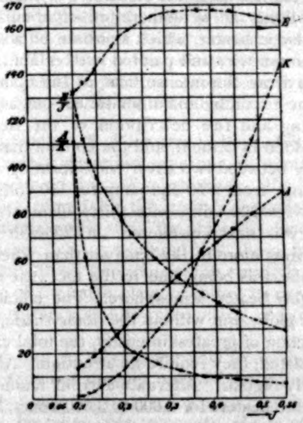
W. H. E.

ELECTRIC LAMPS AND LIGHTING.

2309. *Kallmann's Variable Tariff System.* **Kallmann.** (Elektrotechn. Zeitschr. 22. pp. 676–682, Aug. 22, 1901.)—The author first reviews the systems already proposed, and gives a list of the principal papers which have already been published on the subject. His method is as follows: For each month or each quarter, or even merely for the summer and winter half-year, every central station has a characteristic current-supply curve obtained from the readings of the switchboard instruments, which curve shows the mean value of the consumption-curves of all the consumers; that is to say, it gives the average load-curve for the twenty-four hours of a summer's day or of a winter's day. The area of each of these two curves can be expressed in terms of the tariff, in such a manner that a consumer whose mean consumption-curve corresponds to this central-station load-curve, has to pay the calculated average price per kilowatt-hour, which is fixed from the calculation of the distribution of the fixed and current annual expenses of generation supply and distribution. If the mean consumption-curve of the consumer is below the central station curve, the price for this consumer is correspondingly raised above the average price, since the fixed expenses must be distributed over a small number of kilowatt-hours. Conversely, the price of current is reduced accordingly as the area is greater by which the consumer's consumption-curve exceeds the mean central-station curve. The current so used can be measured by a three-stage or dial meter, or even by a time-measurer having three relays, one of which is actuated, when the current is between 5 and 10 per cent. of the maximum demand, to throw the pointer of one dial into operation, another to be actuated when the current is between 20 and 50 per cent. of the maximum, and a third when the current is over 50 per cent. of the maximum, only one pointer being in operation at a time. A number of numerical examples are given. C. K. F.

2310. *Védovelli's System of Stage-Lighting.* **A. Bainville.** (Électricien, 22. pp. 97–99, Aug. 17, 1901).—In this system, in order to obtain continuously-varying effects, a series of commutators are connected, through friction-wheels on spring-controlled oscillating-frames, to one or other of two shafts rotating in opposite directions, trip-mechanism being provided whereby the frames are released and moved by their springs, so as to bring the friction-wheels out of contact with the driving-shafts, when predetermined points are reached on the commutators; the switch-arms can then be operated by hand. C. K. F.

2311. *The Nernst Lamp.* **W. Wedding.** (Elektrotechn. Zeitschr. 22. pp. 620–624, Aug. 1, 1901.)—The author here gives the results of tests he has carried out on some Nernst lamps. The first set examined consisted of lamps, said to be suitable for lighting small rooms, at 220 volts. The candle-power, with clear glass globes, varied from 24·2 to 55, and the watts per candle (*i.e.*, per Hefner candle), from 1·89 to 1·54. A second set of larger lamps *without* globes included 220-volt lamps, of from 85 to 102 c.p., with efficiencies from 1·01 to 1·2 watts per c.p.; and also 110-volt lamps, of about 70 c.p., with a mean efficiency of 1·4 watts per c.p. The time occupied in lighting varied from 9 to 69 seconds, the average being about 30 seconds. The author then gives a large number of tables and diagrams, referring to the determination of the mean spherical c.p. In the case of a 220-volt lamp *without* globe, the mean illumination in the lower hemisphere was found to be 110·3 c.p., and in the upper hemisphere 96 c.p., the watts consumed being 192·9. This gives an efficiency of 1·87 watts per spherical c.p.; and an ordinary incandescent lamp, similarly tested, had an efficiency of 3·91 watts per spherical c.p., the ratio of the two efficiencies being therefore that of 1 to 2·1. The life of the Nernst lamp at the various efficiencies is not stated. The author next examined a filament, which was subjected to a continuous change of voltage. The results are shown on the adjoining curves. The various quantities are considered as functions of the current J, which is the abscissa. They include the impressed voltage E, the candle-power K, the apparent resistance E/J, the watts consumed A, and the watts per c.p. A/K. The scales of the various ordinates may be ascertained from the fact that, commencing at the left hand of the different curves, E is 132, J is 0·1, K is 1·19, and therefore A is 13·2, E/J is 1,320, and A/K is 11·1. The lamp is intended for a normal voltage of 165. It has a critical point at 168 volts, and if this voltage is reached, the filament will afterwards take 0·51 ampere at 165 volts instead of the normal 0·27 ampere, and will consequently burn out. The existence of this critical point is clearly shown by other diagrams (not reproduced), which treat the variables as functions of the voltage. For the purpose of preventing any dangerous increase of voltage across the filament, a series resistance is used; and figures are given, showing the extent to which this resistance increases at the critical point, and thus absorbs the extra volts. W. H. S.



2312. *The Nernst Lamp.* **A. J. Wurts.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 511–536, June and July, 1901.)—The author gives an account of the work which has been done with a view to developing the Nernst lamp in America. The standard 220-volt filament is about 25 mm. long, and 0·63 mm. in diameter. It is connected to its terminals by means of a platinum bead, embedded in the end in such a manner that any shrinkage of the filament results in tightening the contact, and thus maintaining intimate connection between the platinum bead and the filament. With direct current, electrolytic action shortens the life of the filament; but with 220-volt alternating current, it has been found at the Westinghouse works, where some of these lamps are used for lighting the shops, that the filaments last about 890 hours. On continuous current, 220-volt filaments would be expected to last about 800 hours; those for 110 volts are generally less satisfactory. Various curves are given, showing the connection between volts and amperes, when the filament is run, either in air, in a vacuum, in nitrogen, oxygen, or hydrogen. The curves in air and oxygen are the best of the series, and are very similar to one another. It is therefore concluded that it is best to run the filament in air. The steadying resistance, which is placed in series with the lamp, is made of iron wire, mounted in a glass tube filled with an inert gas; it is worked at such a temperature that a 10 per cent. increase in current increases the resistance of the iron wire by 150 per cent. The filament lights at a temperature of about 950° C.; the initial heating is effected by a heater, which consists of a thin porcelain tube, wound with fine platinum wire and painted with cement, the latter serving to protect the platinum from the intense heat of the filament. The heater is disconnected from the circuit by an automatic cut-out, as soon as the filament is lighted. A drawing and full description of the design of cut-out are given; the coil is bedded in cement, and the contact made by a silver band, which falls by gravity between two silver wires forming a V. The lamps at present developed range from a 50-c.p. lamp for 110 volts, with one filament, to a 2,000-c.p. lamp for 220 volts, with thirty filaments. The complicated question of efficiency is next considered. A 220-volt filament, taking 0·4 ampere, required 20 volts more in the open air than when burning with five others in a 3-inch globe, this being due to the fact that in the latter case the filaments are in a highly heated atmosphere. The efficiency of a 6-filament lamp with clear glass globe, but without the dome shade, is 1·2 watts per c.p. measured in the direction of greatest intensity, the total c.p. being 400. When the lamps are first started, they require no attention. After 1,000 hours, the renewals become fairly regular. Alternate-current filaments are expected to last about 800 hours, the heaters for 2,000 to 3,000 hours, and the series-resistance should last for an indefinite time. The cost of a 6-filament lamp will probably be about 14 or 15 dollars, and for other lamps in about the same proportion. W. H. S.

2313. *Bardon Enclosed Arc Lamp.* **J. A. Montpellier.** (Electricien, 22. pp. 81–82, Aug. 10, 1901.)—In this lamp the upper carbon-holder is controlled by a clutch, consisting of a bar having a hole in the centre through which the carbon-holder passes, and feet at one end adapted to rest on the bottom of the case when there is no current in the lamp. The other end of the bar is connected to one arm of a counterbalanced lever, which has the core of the controlling solenoid suspended from its other arm. Two views are given illustrating the connections, and the method of supporting the inner globe. C. K. F.

REFERENCE.

2314. *Lightning Discharges and the Protection of Aerial Lines.* **H. Müller.** (Elektrotechn. Zeitschr. 22. pp. 601–603, July 25, 1901.)—The author discusses the various ways in which overhead lines are affected by atmospheric disturbances, and critically examines the various forms of lightning arresters. A. H.

TELEGRAPHY AND TELEPHONY.

2315. *Bedell's System of Telegraphy.* **Johnson.** (Électricien, 22. pp. 65–70, Aug. 3, 1901.)—According to this system of telegraphy, transmission takes place in a series of pulsations produced by the employment of a battery or other continuous-current source, the current being modified by the gradual insertion of resistances, or of auxiliary e.m.f.'s, or by the employment, together with the battery, of an alternate-current generator. The modified pulsations are arranged to form a code, in such a way that they can be received, recorded, and interpreted at the distant station. The sending apparatus may take the form of an automatic transmitter, resembling the Wheatstone perforated slip instrument. Two rows of holes may be used, in addition to the row which is used for actuating the slip, so that the current passing to line through one brush can be modified by the simultaneous current passing to line through the other. The form of the pulsation, transmitted through either brush to line, can be modified by rotating rheostats or by alternators. Various methods for attaining these results are described. R. A.

2316. *Wireless Telegraphy.* **S. Kimura.** (Phys. Zeitschr. 2. pp. 571–574, June 29, 1901.)—The author describes experiments he made for the Japanese Admiralty at distances up to thirty English miles. His principal object was to determine the part played by the earth connection. Earth plates of different sizes and materials were tried, the author's telephonic receiver being used instead of a coherer, and it was found that the ohmic resistance of the "earth" was of practically no importance, the strength of the signals being dependent on the size of the earth plate, or rather its capacity. Thus signals were received from a distance of fifty miles, using as earth three oil tins laid upon the grass.

The author draws the further conclusion from these results, that the detection of signals does not depend only on the potential induced in the receiving wire, and that in order that tuning may be effected the capacity of the earth plate must be taken into account. He is of opinion that each oscillation has its effect in reducing the resistance of the coherer, however high that resistance may be at the moment, and therefore that increase of capacity, by prolonging the train of waves, increases the sensibility of the receiver. J. E.-M.

2317. *Wireless Telegraphy.* **L. Lombardi.** (Elettricità, Milan, 20. pp. 278–281, May 4, and 291–294, May 11, 1901. Paper read before the Associazione Elettrotecnica Italiana, March 24, 1901.)—This paper is a historical survey of the progress of wireless telegraphy, and of the phenomena which led up to it, from Kelvin's theory of oscillatory discharges, published in 1853, to Slaby's and Braun's improvements in Marconi's system of telegraphy. These improvements are discussed at some length. G. H. B.

2318. *Rotary Converters* versus *Motor Generators for Telephone-call Signalling.* **D. M. Bliss.** (Elect. World and Engineer, 37. pp. 1031–1032, June 15, 1901.)—The old hand or power generator is rapidly disappearing from the exchange, and in its place is found the more efficient and compact rotary converter or motor generator. Considering efficiency alone, the converter type of ringer is to be preferred; but in a machine in which the total input at the motor does not exceed 200 watts the question of efficiency is secondary to that of reliability and insulation. Since the transformation ratio of a rotary converter cannot be varied, the tendency is to use motor generators for both charging and ringing purposes. The advantages are enumerated, and a specification is given for a 75-watt machine. J. E. K.

2319. *Thermopiles in Telephone Stations.* **Tuch.** (Archiv Post Tele. 14. pp. 454–463, July, 1901.)—This paper describes the trial by the German Post Office of Gülcher thermopiles as a substitute for primary or secondary batteries in telephone stations. Thermopiles of 50 junctions, giving 8 volts, and of 66 junctions, giving 4 volts, were tried. Curves are given showing the variation of volts, amperes, and watts as the number of microphone circuits increased, for accumulators, primary cells, and different arrangements of thermopiles. It was found that the thermopiles, owing to their high internal resistance, did not furnish a corresponding amount of energy as the number of microphone circuits was increased, and that their first cost, upkeep, and the cost of gas far exceeded the costs of accumulators. The thermopiles are now relegated to the Post Office Museum. G. H. B.

2320. *Telephone Line on Snow to the Etna Observatory.* **A. Riccò.** (Accad. Lincei, Atti, 10. pp. 193–196, 1901.)—The telephone line from the Etna Observatory to Nicolosi, originally erected with iron wire on poles, was frequently broken in high winds when the wire was covered with snow. It was then found that good communication could be maintained by laying the wire on the snow, or, where the snow was not continuous, by nailing it to the poles at a height of 180 cm. Steel wire has been substituted for the iron wire on the poles, and has not yet been broken. G. H. B.

2321. *A Humming Telephone.* **F. Gill.** (Elect. Rev. 48. pp. 951–953, 1901. Paper read before the I. E. E. (Dublin Section), April 18, 1901.)—The author describes further experiments made on the effect first noticed by A. S. Hibbard in 1890, that if a telephone be held near to the diaphragm of a microphone, a hum or whistle once set up is continued. The connections are those ordinarily used, the microphone being in series with a battery and the primary of an induction coil, and the telephone in series with the secondary. The author finds that on reversing either the connections of the telephone or the battery current a change in pitch of the hum is produced, but that if both reversals be made simultaneously no change is produced. For the ordinary humming the exact conditions that determine the note given out appear to be very complex; apparently every portion of the circuit and instruments affects the note, but it can be most easily varied by the addition of resistance, capacity, or self-induction. Adding non-inductive resistance raises the pitch but weakens the sound. The addition of self-induction lowers the note, and the same effect is produced by shunting the telephone with a condenser. Variation of the distance between the telephone and microphone diaphragms alters the note; with the higher note increased distance gives a steadily rising pitch; while with the lower note the steady rise of pitch is broken by a sudden change in character. The author suggests the following explanation as probable: When the diaphragms are brought nearer, the current increases, but owing to lag the increase of current does not correspond with the movement of the microphone diaphragm. The telephone diaphragm apparently follows the current more or less accurately, and its air waves take an appreciable time to reach the microphone, resulting in an air lag as well as an electrical lag. The high note is given when the diaphragm of the telephone moves (at the appropriate lag) in the same direction as that of the microphone, and the low note when in the opposite direction. E. C. R.